EYE HAZARDS IN INDUSTRIAL OCCUPATIONS

LOUIS RESNICK
AND
LEWIS H. CARRIS

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EYE HAZARDS IN INDUSTRIAL OCCUPATIONS

by LOUIS RESNICK
and LEWIS H. CARRIS

A handbook for safety engineers, safety inspectors, safety committeemen, industrial physicians and nurses; for those responsible for industrial operations, whether owners, managers, or members of the operating staff; for governmental officials, trade association executives, and social agency officers; and for the many others who share the responsibilities and opportunities for conserving the life, health and sight of the millions of men, women and children employed in industry.

APRIL, 1924

NATIONAL COMMITTEE FOR THE PREVENTION OF
BLINDNESS, Inc.
130 East Twenty-Second Street, New York City

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This publication is to replace Publication 12, "Eye Hazards in Industrial Occupations," issued by the National Committee for the Prevention of Blindness in 1917 and prepared by Gordon L. Berry and Thomas P. Bradshaw

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FOREWORD

The National Committee for the Prevention of Blindness, organized in 1915 for the purpose indicated in its name, has from the beginning sought to bring the eye hazards of industrial occupations and the means of eliminating them to the attention of industry and of the country at large. Toward this end the Committee published in 1917 "Eye Hazards In Industrial Occupations," prepared by Gordon L. Berry and Thomas P. Bradshaw as the result of a survey conducted in Buffalo during 1916 and other studies made by the staff of the Committee.

In 1922 the Committee undertook a revision of the original publication under this title. As this work progressed, it became apparent that so much had been accomplished in the prevention of eye accidents since 1916 and so many new hazards had developed that the preparation of a new publication rather than revision of the original volume would be necessary. All the material of the old book according with present approved practices among safety engineers, employers and employes generally is, however, incorporated in the present publication.

In publishing this volume the National Committee for the Prevention of Blindness undertakes to serve as a clearing house for the great fund of information regarding this particular hazard of industrial occupations developed by the numerous industrial associations, governmental agencies and individual corporations interested in accident prevention and health promotion. Many organizations, such as the National Safety Council, the United States Bureau of Standards, and the American Museum of Safety, have done splendid work in the general field of accident prevention and through that work have contributed largely to the prevention of eye accidents and the conservation of vision. Yet, after all, eye accidents constitute only one of the many groups of serious accident and health hazards confronting industry, and no organization has heretofore been able to give this one group of hazards the study it deserves.

This publication was prepared by Louis Resnick, Director of Publicity, and Lewis H. Carris, Managing Director of the National Committee for the Prevention of Blindness. Mr. Resnick, formerly editor of the *National Safety News*, has had wide experience in investigating the accident and health hazards of industry and the efforts which are being made to eliminate these hazards. Mr. Carris has had direct contact with industry through his vocational education experience and his work in vocational rehabilitation.

The Committee also had the assistance of Edward M. Van Cleve, formerly Managing Director of the National Committee for the Prevention of Blindness, Preston S. Millar of the Electrical Testing Laboratories, and of such well known ophthalmologists as Dr. F. Park Lewis, Buffalo, Dr. Ellice M. Alger, New York City, and Dr. Conrad Berens, Jr., New York City.

It is hoped that this publication may help to reduce the great loss of health, happiness, and wealth caused by preventable eye hazards, and thereby prove of service to employer, employe, and society at large.

William Fellowes Morgan,
President, National Committee for the
Prevention of Blindness

ACKNOWLEDGMENT

The publication of this book would not have been possible without the generous and valuable assistance of the many organizations, corporations, and private individuals who placed at our disposal information, photographs, and their personal services for consultation and criticism of manuscript. Among those who deserve special thanks are: Charles L. Close, Manager of the Bureau of Safety, Sanitation and Welfare, United States Steel Corporation; George E. Sanford, Safety Engineer, General Electric Company; C. P. Tolman, Consulting Engineer, National Lead Company; Sydney J. Williams, Chief Engineer, National Safety Council; Harry Guilbert, Safety Director, Pullman Company; Robert A. Shaw, Safety Director, Ford Motor Company; G. A. Orth, Safety Director, American Car and Foundry Company; Clarence Law, President, Illuminating Engineering Society; C. W. Price, Vice-President, Elliott Service Company; Walter King, Director of Safety Division, American Optical Company; and Arthur Williams, President of The American Museum of Safety.

Louis Resnick
Lewis H. Carris

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EYE HAZARDS IN INDUSTRIAL OCCUPATIONS

CHAPTER I

INTRODUCTION

The science of human rehabilitation has developed artificial hands, arms, and legs that can do almost anything the human member can do. But no one has yet produced an artificial eye that can see. Nor does anyone dare predict that the day will ever come when it will be possible to replace the human eye with an artificial eye that will see.

This fact, alone, makes the eye hazard the most serious of all non-fatal industrial accident hazards. Even when we put aside all social, humanitarian, or other considerations, and look at the problem purely from the economic point of view, the eye hazard in industrial occupations still ranks second only to death in seriousness.

What, in a nutshell, are the eye hazards of industry?

Foremost, of course, are the accident hazards: flying chips of metal, mineral, or wood; splashing liquids—molten metal, acids, or other injurious chemicals; and explosions of endless variety. Then there are the hazards of infection and of eye diseases: through neglect of eye injuries; through incompetent first aid treatment; through contact with carriers of contagious disease; and through exposure to excessive radiated heat. Finally there is eye strain resulting from improper or inadequate lighting; from improper vocational placement; from ignorance of, or disregard for, the existence of defective vision.

It is true that much has been accomplished toward the alleviation of these conditions by the development of the safety movement during the last decade, particularly through the work of such organizations as the National Safety Council, the Safety Institute of America, the American Society of Safety Engineers, and the various state industrial commissions, trade associations and technical societies which have interested themselves in accident prevention and in the general improvement of working conditions.

But all that has been accomplished thus far is only a beginning. There are still countless plants, whose operations present serious eye hazards, in which no goggles are available even for the workman who, on his own initiative, might apply for them. There are many plants where workmen wear goggles on their caps or in their pockets, except when "the boss" is watching them. There are still plants which boast of shop mechanics who are "expert" at removing cinders and other particles from the eyes of fellow workmen with toothpicks, matches, nail files, handkerchiefs, or the tongue.

Two facts account for the presence of such conditions so late in this era of industrial efficiency. First, as a rule, only those plants which are large enough to afford a safety engineer and progressive enough to keep accurate record of their accident experience realize that the eye hazard is the most serious and most costly of all non-fatal accident hazards. Second, the eye accident hazard is only one of the many serious hazards over which the activities and resources of safety organizations, trade associations, and industrial commissions must be spread. This also is the situation within the individual industrial property. Only in the plant where there has been a high frequency of costly eye accidents is special attention given to this particular class of accidents.

In the average small plant, where a serious accident may not happen more than once in several years, and in the average large plant in non-hazardous industries, where serious accidents are infrequent occurrences, both supervisors and employes often get into the habit of looking upon every serious accident as a "freak accident," one that "would not happen again in a hundred years." Where there is such an attitude, little or no effort is made to prevent the recurrence of that particular type of accident. But when the tens of thousands of small plants and the hundreds of non-hazardous large plants are considered in the aggregate, the so-called freak or rare eye accident blinds a man, woman, or child somewhere in the United States every day in the year.

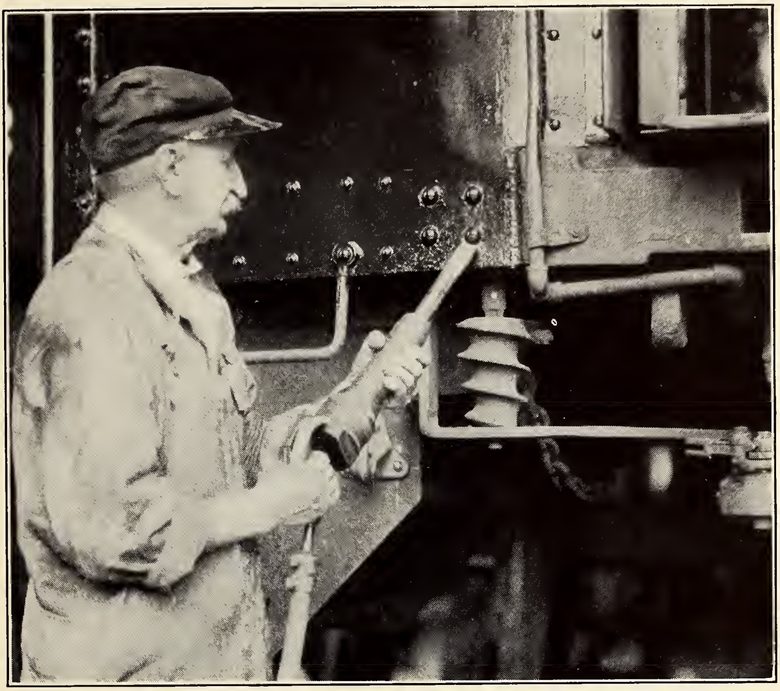

Figure 1.—Cutting rivet heads with pneumatic chisels presents one of the most serious eye hazards in all industry; nevertheless, thousands of employes, like this man, are daily risking their sight by working without wearing substantial goggles or masks.

Fifteen Thousand are the Industrial Blind

It is not surprising then to learn that of the 100,000 blind persons in the United States, approximately 15,000 are "the industrial blind," persons who have lost their sight in the pursuance of industrial occupations, and that there is, in addition to the totally blind, a much larger number of men, women, and children whose vision has been so impaired by the eye hazards of industry that they are handicapped throughout life. Both of these classes, the industrial blind and the workers whose vision has been seriously impaired by the hazards of their industrial environment, grow larger each year.

The National Safety Council has estimated that there are annually in the United States about 200,000 industrial accidents resulting in injury to the eye—an injury to an eye every 3 minutes, day and night, 365 days a year. The great majority of these accidents, fortunately, do not result in permanent injury. In the State of Pennsylvania, however, during the year 1923 there were 649 industrial accidents resulting in the total loss of one or both eyes. In Wisconsin during 1920 there were 148 industrial accidents resulting in permanent injury to eyes. In California, during a recent five year period, there was a yearly average of 10,470 accidents to eyes of which 206 resulted in permanent injuries. Indiana during 1922 reported 4,291 industrial eye accidents. Illinois during 1921 reported 1,887 such cases. New York State during 1920 reported 1,568 industrial accidents resulting in eye injuries.

The very incomplete statistics available, considered in the most conservative light, justify the estimate that several thousand human eyes are blinded forever through industrial accidents in the United States each year, and that many more thousands of persons each year suffer partial, but permanent, impairment of vision through such accidents.

After analyzing the causes of 29,242 cases of blindness, Harry Best, in his book, "The Blind," comes to the conclusion that "external injury constitutes the most important cause of blindness through the greater part of life." A study of the distribution of serious eye accidents by industries—the results of which are tabulated in the next chapter—shows that hardly any industry is free from this type of accident.

Legislation

The solution of this problem depends chiefly upon three forces: legislation, education and organized accident prevention activities in industry. There must, first of all, be laws requiring the reporting of accidents, specifying safeguards, and providing for the compensation of injured workers. Without overlooking the sincere humanitarian motives underlying the safety activities of many industrial executives, or the purely economic or good business reasons that account for the accident prevention work of many other industrial concerns, it must be admitted that it was workmen's compensation legislation that provided the greatest stimulus for the industrial safety movement. The pressure of competition is so strong; the temptation to take a chance is so nearly universal, among employers as well as employes; and finally it is so easy to relieve one's conscience of any responsibility for an accident by saying, "It was his own fault; any fool would know better than to attempt that job without goggles," that it is doubtful whether industry would even today give as serious attention to accident prevention as it is giving, if it were not for existing legislation.

In a state where there is no law requiring the safeguarding of accident and health hazards, where there is no law requiring employers to compensate workmen for injuries received during the pursuit of their occupations, where there is no law requiring even the reporting of accidents—and there are such states in our United States—little effort will be made for the prevention of accidents. That is why intelligent legislation—fair both to employer and employe—is a prerequisite for the prevention of eye accidents, as well as for other forms of industrial safety work.

Education

Legislation, even when prepared by persons who have an intimate knowledge of the subject and when judiciously enforced, is in itself not enough. Education of workmen, foremen, superintendents, plant managers and of owners themselves is just as important, because of the fact that many accidents result from causes that cannot be guarded by any mechanical means. The United States Steel Corporation, for instance, in an analysis of more than a quarter million accidents in its numerous plants found that hand labor was responsible for 44.04 per cent, or nearly one-half of all accidents.

"The majority of these accidents," the Steel Corporation's report says, "could not possibly have been prevented by the use of mechanical safety devices or appliances, but were due to carelessness and the failure of the workmen to observe simple precautions conducive to safety."

Legislation may compel industry to build and maintain its shops safely. It may compel the employer to compensate workmen for injuries. But all the legislation in the world cannot keep a workman from shoving his goggles up to his forehead when he is not being watched, if that workman has not been convinced that he should wear goggles every minute of the time during which he is engaged in work that presents a serious eye hazard. Only education can do that. Legislation can do nothing for the workman who, getting a cinder in his eye, lets a fellow workman try to remove it with his tongue, and loses the eye through the resultant infection. This happened not long ago under circumstances where it would have been just as easy for the workman to go to the plant dispensary. Only education—persistent, carefully planned, and sympathetic education—can prevent that.

Accident Prevention

Given ideal safety legislation and thoroughgoing safety education, there is still the need for definite and carefully organized accident prevention activities within the individual plant, mine, railroad or other place of work. Mechanical guards and safety devices must be designed, purchased or manufactured, installed and maintained in working order. There must be frequent inspection of plant conditions and operating methods. Intelligent supervision is necessary. Illustrated posters, warning signs, and other forms of safety literature are needed. A later chapter discusses the possibilities of preventing accidents by engineering revision or changes in the design of machines, tools, and manufacturing processes.

For the prevention of accidents within the plant itself through means other than education there are almost unlimited opportunities. New devices and methods are being developed each day. The various national and local safety associations, the more progressive industrial commissions, and the insurance companies are doing much in this direction. The individual professional safety man, however, constitutes, in the aggregate, the backbone of this most important of the three principal forces for accident prevention.

The position of the National Committee for the Prevention of Blindness in this field is that of a clearing house or central agency for the collection and dissemination of information concerning the causes of eye hazards and the means of their reduction and ultimate elimination. The functions of this Committee are to throw light on existing conditions, to suggest methods of correction and prevention, to stimulate interest in the subject, and to co-operate with other bodies seeking to eliminate the eye hazards of industry.

The power to enforce action, of course, rests with such regulatory bodies as industrial commissions and factory inspection departments; the opportunities for rendering professional and material service are in the hands of the various safety organizations, trade associations, technical societies and insurance companies. The greatest opportunity for the elimination of eye hazards rests with the individual industrial executive, the superintendent, the safety engineer, the foreman, and the safety committeeman.

The Point of View

The task of unearthing and assembling the available information on the subject of this volume was undertaken with no particular point of view in mind. But it soon became apparent that the collation of this material—if it were to produce anything more than a mere narrative account of facts, figures, ideas and experiences—must be predicated on a very definite and unchanging point of view. This viewpoint may be summarized as follows:

> FIRST, the elimination of eye hazards in industry is not only a moral obligation, but a good business proposition;
>
> SECOND, goggles at best are a handicap; the first effort, therefore, should be directed toward elimination of the hazard itself by revising the process of manufacture, by redesigning the machine or tool, or by guarding the machine or tool at the point of operation.
>
> THIRD, few people have normal vision; greater attention should, therefore, be given to examination of the eyes of employes, to consideration of the condition of the eyes with relation to the visual requirements of the job, and finally to the correction of defective vision and the treatment of eye diseases and eye infections among employes.

The Dollar Cost of Industrial Eye Hazards

Three principal factors contribute to the monetary cost of industrial eye hazards: first, the direct cost of compensation for injuries to the eye; second, the indirect cost resulting from the spoilage of raw materials and finished products, the latter often including extensive labor costs; and, third, the natural slowing up of the individual's work and of the whole industrial machine resulting from defective vision, from poor lighting, from accidents to the eye, and from other accidents caused wholly or partially by poor vision.

It is not possible to present statistics showing these costs for the nation as a whole. Even in the matter of compensation for eye injuries we must content ourselves with indicative statistics, because only a few state industrial commissions have tabulated this information, and among these there is little uniformity in method of compilation. It is reasonable to suppose, however, that the experiences of Pennsylvania, Illinois, California, Wisconsin, New York, Washington, and Ohio—because of their geographic distribution and the diversity of their industries—are representative of the country at large.

In Pennsylvania during the eight years since the inception of the Workmen's Compensation Act more than 40 per cent of all the compensation awarded for permanent injuries was awarded for loss of eyes. During these eight years a total of $15,332,220 was awarded as compensation for permanent injuries and of this amount $6,201,763 was for loss of eyes. The compensation paid for loss of eyes in Pennsylvania throughout this period was greater than the combined compensation for loss of legs, loss of arms, loss of feet, and permanent disability from miscellaneous injuries. The awards of compensation for permanent injuries in Pennsylvania from January 1, 1916, to January 1, 1924, follow:

Loss of legs	$1,606,408
Loss of arms	1,257,853
Loss of feet	1,639,774
Miscellaneous permanent injuries	779,044
Total	$5,283,079*
Loss of eyes	$6,201,763

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* This, together with the $6,201,763 awarded for loss of eyes, $3,449,469 awarded as compensation for loss of hands, $272,889 for fingers, and $125,020 for phalanges makes the total of $15,332,220 awarded for all permanent injuries.

What are conditions today in the average industrial plant with respect to eye accidents, their frequency, and the efforts being made for their prevention? This is the question which keeps cropping up in one's mind in studying the problem of eliminating the eye hazards of industrial occupations. Little definite information is available to answer this question.

The eye accident experience of the Pennsylvania Railroad System, shown in Table I, may be conservatively considered typical because this road has for many years given considerable attention to accident prevention and health promotion. It will be noted from this table that during the period of 1918 to 1922, inclusive, in this one industrial property an average of 36 eyes per year were lost, an average of 2,000 eyes per year were injured, and an average of 17,000 days per year were lost by employes whose eyes were injured. If the eyes lost are computed at the standard weighted disability of 1,800 days per eye, the yearly average of time lost as the result of eye injuries becomes 81,000 days instead of 17,000 days.

Uniform Statistics Needed

When industry as a whole awakens to the seriousness of its eye hazards, it may be possible to gather statistics which will provide an authentic answer to this question. For then all eye injuries will be reported and tabulated in such a way as to show the severity of different types of eye accidents and their relative importance as compared to other types of industrial accidents. There is in existence already a standard accident report form, devised and approved by the International Association of Industrial Accident Boards and Commissions and the United States Bureau of Labor Statistics, and a table of weights for computing the seriousness of accidents in terms of days lost. This form and table are now in fairly wide use; when they have been generally adopted throughout industry it will be much easier

TABLE 1.—EYE ACCIDENTS TO EMPLOYES OF THE PENNSYLVANIA RAILROAD SYSTEM, CLASSIFIED BY NATURE OF INJURY FOR YEARS 1918 TO 1922, INC.

	1918		1919		1920		1921		1922	
	Accidents	Days disability	Accidents	Days disability	Accidents	Days disability	Accidents	Days disability	Accidents	Days disability
Strains	16	60	11	48	6	31	2	14	..	..
Bruises	239	2,135	197	1,567	185	1,882	279	2,288	485	3,749
Bruises, lost 1 eye	5	400	3	113	4	458	..	..	2	109
Lacerations	248	3,082	249	2,744	250	3,244	191	2,390	151	2,147
Lacerations, lost 1 eye	30	2,131	50	5,747	33	2,389	19	1,302	26	2,065
Electric Flashes	10	78	6	56	18	233	13	43	36	183
Electric Flashes, lost 1 eye	1	9	..	..	..	..	..	..	..	..
Burns	178	1,568	136	840	179	1,454	111	944	205	1,542
Burns, lost 1 eye	2	315	..	..	1	59	3	306	..	..
Foreign particles, cinders	1,622	8,843	1,490	8,717	1,711	9,181	1,030	5,377	1,358	7,667
TOTAL EYES INJURED	2,313	15,766	2,089	13,972	2,349	16,025	1,626	10,996	2,235	15,288
TOTAL EYES LOST	38	2,855	54	5,950	38	2,904	22	1,608	28	2,174
TOTAL EYE CASES	2,351	18,621	2,143	19,922	2,387	18,929	1,648	12,604	2,263	17,462
TOTAL ALL INJURIES	33,717	489,262	28,058	425,420	31,196	421,783	19,795	297,154	27,086	393,433
Per cent Eye Cases of all Injuries	7.0		7.6		7.7		8.3		8.3	
Average Number Employes	241,114		263,252		269,502		202,885		209,890	
Eye Injuries per 1000 Employes	9.6		7.9		8.7		8.0		10.6	

to obtain a true picture of the eye accident situation in the country at large.

It is interesting to note, as an indication of the seriousness with which eye accidents are regarded by state commissions and the Department of Labor, that accidental loss of the sight of both eyes is weighted in this standard table as 100 per cent disability, or the same as accidents causing death or permanent total disability. Such accidents are computed at the rate of 6,000 days lost, and these three classes mentioned are the only ones rated as 100 per cent disability and 6,000 days lost. Loss of one eye is rated as 30 per cent disability and computed as 1,800 days lost.

A Cross-Section of Industry

The National Committee for the Prevention of Blindness felt that if it could get a cross-section view of the situation in a large group of plants known to be doing good safety work, it would be possible from this picture to deduce what the situation may be in the average plant where little serious attention is being given to accident prevention. The committee accordingly sent to a large number of representative plants, in which good safety work is being done, a questionnaire in which they were asked to supply data covering the year 1922 on the following points:

Nature of business.
Average number of employes.
Average number of goggles in use.
Number of goggles damaged in use.
Number of eye injuries.

The answers to this questionnaire show that in seventy-two plants employing approximately 168,000 men, the eyes of 15,989 workers, or almost 10 per cent of the total working force, were injured during the year 1922. On the other hand the eyes of 1,522 workers were saved from certain serious injury—if not permanent disability—by the wearing of goggles, for the seventy-two plants reported that number of goggles damaged in use by splashing molten metal or destructive chemicals and by flying fragments of metal. If these goggles had not been in front of the eyes of the workers involved, their eyes instead of the goggles would have been burned by hot metal or acid, or pierced by splinters of steel. It should be remembered also that the goggles of each workman stop in a year many flying objects which do not damage the goggles but which would seriously injure the delicate organs of vision behind the goggles, so that the real number of eyes saved by goggles in these plants was far greater than this figure indicates.

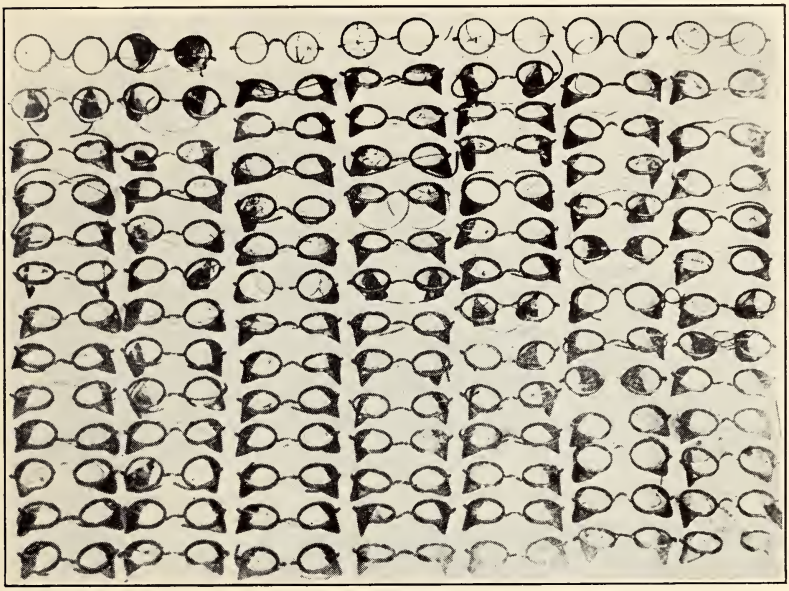

Figure 2.—Ninety-four pairs of broken goggles collected in three months by the American Steel Foundries. Each pair saved a man's sight.

The questionnaire developed the fact that in these plants, employing more than 168,000 workmen, only 18,205 pairs of goggles are in use. The fact that this number of goggles is inadequate is shown by the striking difference of the ratio of goggles in use to the number of employes in different plants within the same industry. For instance, one steel plant employing 180 men reported that 180 pairs of goggles are in use, while another company operating a number of plants in the same industry reported 7,500 employes and 950 goggles; one mining and smelting company reported 1,800 employes and 500 goggles, while another company in the same business reported 1,400 employes and 31 pairs of goggles; one tire and rubber company with 11,000 employes is using 1,500 pairs of goggles while another company in the same field with 4,400 employes is using only 25 pairs of goggles. The conclusion is obvious: in many plants, even among those giving serious attention to safety work, the first essential for the prevention of injury to the eye—the provision of a pair of goggles for each workman engaged in hazardous work—is overlooked. These returns indicate, also, that the practice of providing one pair of goggles for the common use of a room-full or

Figure 3.—Fourteen men from one department of the General Electric Company's plant at West Lynn, Mass., whose eyes have been saved by goggles. The goggles shown in Figure 9 were worn by one of the men in this group.

department-full of workmen is still prevalent in many industrial establishments.

The replies to the questionnaire revealed also that even among these plants, which are known to be among those doing the best safety work in America, only 26 out of 72 examine the eyes of all new employes; 43 plants report that they make no examinations of the eyes of workmen; one company examines the eyes of about 75 per cent of its employes; and one railroad examines the eyes of trainmen only.

It is apparent from the replies received that the eye hazards are most serious in metal working plants. A group of twenty metal working plants—including machine, tool, electrical equipment, typewriter, saw, car wheel, brass, stamping, farm implement, gasoline motor, firearms, tank, and pump works—reported 6,769 injuries among a total of 30,980 employes, or an average of an eye injury for every five employes, whereas a similar analysis of the replies of a group of thirteen companies, including two railroads, four automobile plants, and seven plants in the chemical and allied industries shows 4,688 injuries among 42,137 employes. The proportion of eye injuries to the number of employes in other industries was still lower. The replies from a group of 22 miscellaneous industrial plants—including shoe, asphalt, paper, glass, abrasives, electric lamp, furniture, construction, camera, gas, cement, electric power, shipbuilding, rubber, lumber, car building, and meat packing plants—show a total of 3,743 eye injuries among 69,203 employes or one injury for every 19 workmen.

This is the situation in the most progressive industrial properties in America, in plants which have the reputation of doing good safety work. The situation naturally is much worse in the thousands of other plants, where safety work is not organized on an efficient basis, or where no organized effort is being made to prevent accidents or to safeguard the health of employes.

CHAPTER II

NATURE AND CAUSES OF EYE INJURIES

Where do eye accidents happen? Everywhere in industry is the most accurate answer to this question. A tabulation of injuries in which compensation was incurred in Pennsylvania during 1920 indicates that of all the industries in which there were accidents of any sort, only three—clothing manufacture, laundries, and tobacco—had no permanent eye injuries that year.

There is hardly an industrial occupation in America which does not add each year to the steadily increasing number of the industrial blind and near blind. For instance, the permanent eye injuries for which compensation was paid in Pennsylvania during 1920 are summarized under the following fourteen general industrial divisions, in the order of the severity of their eye hazards, and the number of eyes lost in each during that year:

Coal mines	244
Metal and metal products	220
Public service	58
Building and contracting	56
Clay, glass and stone products	17
Chemical and allied products	13
Lumber and its manufacture	11
Food and kindred products	9
Liquor and beverages	9
Paper and printing industries	5
Textiles	5
Leather and rubber goods	3
Jobbers and warehouses	3
Hotels and restaurants	1
Total	691

It will be noted from this tabulation that 66 per cent of all the eyes lost in Pennsylvania during 1920 were lost in the coal mines and the metal industries of that state, 8 per cent in the building and construction trades, 8 per cent in public service operations such as telephone, telegraph, gas, and electric utilities, and steam and electric railroad operations. The remaining 18 per cent are scattered through ten other groups of industries.

The surprising element of this record is the fact that coal mining takes precedence even over the metal producing and metal working industries in severity of eye accidents. The metal industries have always been looked upon as constituting the most prolific source of industrial blindness.

A closer approximation of the situation from a national point of view is provided in the following distribution of 1,049 cases of eye injuries involving permanent disability, reported by The Travelers Insurance Company.

Metal manufacturing	424
Woodworking	102
Foundries	76
Laborers (ditch digging, etc.)	63
Coal mines	61
Chemical industries	56
Quarrying and stone cutting	55
Masonry and concrete work	52
Stores	52
Carpentry	46
Farming	18
Textile industries	12
Glass and glassware manufacturing	9
Others	23
	1,049

These figures are derived from the compensation experience of one of the largest casualty underwriters in the country, extending over a period of three and a half years, and covering practically every state and every industry of consequence in America. Even this table, however, does not present a true picture of existing conditions because it does not include the experience of those industries in which the largest employers are self-insurers.

The loss of 52 eyes in the presumably safe occupation of merchandising, of 18 eyes in farming, and of 12 eyes in the manufacture of textiles—the loss of these 82 eyes in the three and a half years' experience of just one insurance company—is further proof of the statement that serious eye accidents are likely to occur wherever men, women, and children are employed. There is no such thing as a really non-hazardous occupation.

How do eye accidents happen? The Industrial Commission of Wisconsin has gone into this subject more thoroughly, perhaps, than any other state body. Table II presents an analysis of the nature and causes of the compensable eye accident cases settled in Wisconsin during the year 1921.

It should be noted that in Wisconsin, at least, hand tools constitute by far the greatest single cause of eye injuries, being responsible in this state for 44 per cent of all compensable eye injuries. Next in the order of their severity—measured in terms either of time lost or compensation incurred—are flying particles, metal working machinery, hot and corrosive substances (including molten metals, chemicals, steam, etc.).

The 1,049 cases of permanent eye injuries reported by The Travelers' Insurance Company, when analyzed as to general cause, show the following distribution:

Flying bodies	829
Hit by tools or moving parts of machine	83
Splashing liquids (molten metal or acid)	70
Explosions	30
Falls	28
Infections	9
	1,049

TABLE II.—NATURE AND CAUSES OF INDUSTRIAL EYE INJURIES IN WISCONSIN; CASES SETTLED DURING 1921

Cause	Total No. of injuries	Temporary injuries	Days* lost	Indemnity	Medical aid
Prime movers	2	2	48	$103	$76
Transmission apparatus	2	1	372	387	41
Wood working machinery	18	13	8,405	8,955	1,359
Metal working machinery	73	54	20,867	24,290	5,374
Paper and paper products machinery	4	4	56	84	120
Leather working machines—sewers	1	1	14	14	41
Dairy products machines	1	1	7	3	43
Textiles machines	1	1	7	2	6
Building and engineering machinery	3	1	867	945	198
Clay, glass and stone working machinery	1	1	9	7	16
Farm machinery	2	1	592	744	433
Cranes and derricks	2	1	1,811	4,000	279
Autos and motorcycles	4	2	2,027	2,358	211
Animal drawn vehicles	1	..	1,800	2,341	203
Dragging or skidding	1	1	12	15	8
Falling objects	13	7	8,407	8,341	1,318
Falls of persons	4	4	80	179	131
Stepping on or striking against	35	26	12,391	10,346	1,791
Hand tools	143	83	72,613	84,114	13,391
Handling objects	4	4	60	102	59
Flying particles	100	71	33,009	32,576	5,924
Electricity	9	9	143	201	173
Explosives	2	1	1,850	1,246	322
Steam pressure apparatus	1	1	14	20	27
All other explosives	6	3	2,387	2,033	553
Hot and corrosive substances	67	51	22,326	22,331	4,125
All Causes	508	350	193,989	$211,613	$36,615

* NOTE.—Days lost due to permanent total and permanent partial disability are computed on the basis of the table established by the Committee on Uniform Accident Statistics of the International Association of Industrial Accident Boards and Commissions.

Some information concerning the nature and causes of 2,673 eye accidents in the iron and steel industry is contained in Bulletin No. 298 of the Bureau of Labor Statistics, U. S. Department of Labor, entitled, "Causes and Prevention of Accidents in the Iron and Steel Industry." This report covers 654,000,000 man-hours of exposure in the iron and steel industry, 1915–1919. Analysis of the data on which the report is based shows, in Table III, the distribution of eye injuries by general causes and by department in which the injury occurred.

Problem Most Serious In Fabricating Department

Note that the last column of Table III shows the ratio of eye accidents in each department to all accidents in that department. It is apparent on this basis that the eye accident problem is most serious in the fabricating departments of iron and steel plants, constituting 17 per cent of all accidents in such departments. It will be noted that in eight of the twelve major departments in the iron and steel industry, the ratio of eye injuries to all injuries exceeds the generally accepted estimate of 10 per cent for industry at large. The sheet rolling mills and plate mills seem to be the only departments in the industry in which eye hazards are not of major importance. Concerning the causes of eye injuries in the iron and steel industry the statistics from which this tabulation was prepared reveal only the fact that the principal factors, in order of their severity, are: hot substances, handling objects, and tools and machinery.

The nature and, incidentally, the high frequency of eye injuries in the shipbuilding industry are shown in Table IV, a division of 4,343 eye cases treated during 1922 at the dispensary of the William Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa. Lay terms are inserted by the editor.

TABLE III.—ALLOCATION OF EYE INJURIES IN THE IRON AND STEEL INDUSTRY

Department where injury occurred	Machinery	Steam apparatus	Power vehicles	Hot substances	Falls of workers	Falling objects	Handling objects and tools	Unclassified	Total eye injuries	Ratio of eye accidents to all accidents
Mechanical	126	..	..	19	..	1	73	228	447	8.0%
Blast furnaces	3	..	2	56	1	2	25	195	284	13.3%
Open hearths	2	..	..	91	2	1	34	150	280	8.3%
Fabricating	26	..	..	13	..	..	54	185	278	17.0%
Foundries	18	..	..	33	..	..	57	130	238	14.4%
Heavy rolling mills	8	..	..	41	..	2	33	119	203	8.4%
Yards	3	..	1	6	..	..	12	86	108	8.0%
Plate mills	2	..	..	27	2	..	10	48	89	4.2%
Tube mills	8	..	..	16	..	..	13	43	80	12.8%
Bessemer	2	..	1	20	..	1	3	48	75	13.3%
Electrical	10	..	..	10	..	1	8	31	60	12.2%
Sheet rolling mills	5	..	..	4	..		5	11	25	3.5%
Unclassified	86	1	1	78	2	3	85	250	506	7.0%
Total	299	1	5	414	7	11	412	1,524	2,673	9.5%

TABLE IV.—NATURE OF EYE INJURIES IN SHIPBUILDING

Abrasions	63
Amblyopia (dimness of vision)	1
Bleb (blister)	1
Blepharitis (inflammation of the eyelids)	1
Brass chips	4
Burns	206
Cataracts	3
Chalazion (tumors of the eyelid)	28
Choroiditis (inflammation of the choroid)	1
Ciliary injection	1
Conjunctivitis (inflammation of eyelids)	430
Contusions	61
Cysts	6
Dacryo-cystitis (inflammation of the tear-sac)	1
Dirt and dust	41
Eczema of lids	1
Electric ophthalmia (inflammation due to electricity)	162
Emery	22
Epiphora (abnormal overflow of tears)	1
Foreign bodies	1,699
Frontal sinusitis	1
Glass	6
Glaucoma	1
Granular lids	1
Infection	3
Iritis (inflammation of the iris)	1
Lacerations	23
Lenticular changes (changes in lens)	3
Lithiasis	1
Paint	8
Poor vision	2
Pterygium (growth over cornea)	1
Puncture wound	2
Rust	695
Sawdust	1
Scale	552
Steel	79
Styes	100
Sub-conjunctival hemorrhage	2
Supraorbital neuralgia	3
Tumor	2
Ulcers—corneal	121
Miscellaneous	2
Total	4,343

In the dispensary and first aid rooms of this company 38 per cent of all work done during 1922 was eye work, principally the removal of foreign bodies not embedded.

All of this information is, however, meager when the magnitude of the whole problem is considered. Until industry knows exactly where, when, how, and why eye accidents occur it will not be in a position to do justice to the existing opportunities for the elimination of such accidents, much less to develop new means of prevention. The keeping of detailed and accurate records of the nature, causes, and costs of eye injuries on the standard basis developed by the International Association of Industrial Accident Boards and Commissions is, therefore, recommended as the first step in any campaign for the prevention of eye accidents in the individual industrial plant or in any specific industry.

CHAPTER III

ELIMINATING EYE HAZARDS BY ENGINEERING REVISION

At the outset the tendency of the general industrial safety movement was entirely in the direction of mechanical guarding. The simple fact that accidents could be prevented by covering up the dangerous parts of machines was, in itself, such a surprising discovery that for a number of years little attention was given to other forms of accident prevention.

Later, safety engineers began to realize that guarding was not a cure-all; that many workmen were habitually careless, thoughtless, reckless, or ignorant; that personal characteristics were causing accidents which it was impossible to prevent by any form of mechanical guarding. Industries here and there set out to counteract this carefree, careless, reckless spirit among their workmen, and to eradicate the ignorance so often the cause of accidents. Safety campaigns were started within individual plants. Such slogans as "Safety First," "A.B.C.—Always Be Careful," "Safety All Ways," "Don't Get Hurt," and a thousand others were brought into play with good effect in many plants.

This was the beginning of the education movement in the field of accident prevention. In every plant where serious and permanent attention is being given to accident prevention, these two forms of safety work—mechanical guarding and education of workmen and foremen—constitute the backbone of the entire accident prevention program.

Within the last few years, however, a third and, in the opinion of many, an even more fundamental form of accident prevention has been developed. It is commonly referred to as "engineering revision," but the term is elastic. The expression, "engineering revision," was—in the words of Dr. Lucian W. Chaney of the U. S. Bureau of Labor Statistics, one of its earliest and most persistent advocates—devised to include in a single brief expression the widest possible application of engineering skill to the safety of industrial plants.

Briefly, the term engineering revision as applied to industrial safety work is generally understood to mean the changing of a manufacturing process, the re-designing of a machine or tool, the rearranging of the physical equipment of a plant, or the changing of the method of work in any other way for the purpose of preventing accidents. Engineering revision aims at the elimination of the underlying cause of accidents rather than the covering up of danger points. Sometimes the cause is a step in a century-old manufacturing process; sometimes it is a mechanical cause; often it is a personal factor, such as the piece worker's willingness to take a chance in order to increase his output and wage, or a workman's desire to display his daring, or his inclination to take the easiest way even if it happens also to be the dangerous way.

One of the most striking and most easily understood forms of engineering revision is the automatic machine. This reduces the number of men necessary to turn out any given amount of work, thereby reducing the number of men exposed to accident hazards. It is, moreover, usually easier to guard the point of operation of an automatic machine than that of a hand-fed or hand-operated machine.

The whole subject of accident prevention through engineering revision is still more or less in its infancy, though a number of striking instances of its effectiveness are on record. The subject is being more and more discussed at safety meetings, and it is probable that within a few years engineering revision will become as common a means of accident prevention as mechanical guarding and education of workmen are today.

The necessity of developing to the utmost the possibilities of engineering revision as a means of preventing injuries to the eye is particularly urgent because it must be admitted that even the best goggles are a handicap and that, if anything can be done to make them unnecessary, the results are bound to be good from the standpoint of efficiency as well as that of safety. The possibility of eliminating eye hazards by means other than the use of goggles is greater than most safety men recognize.

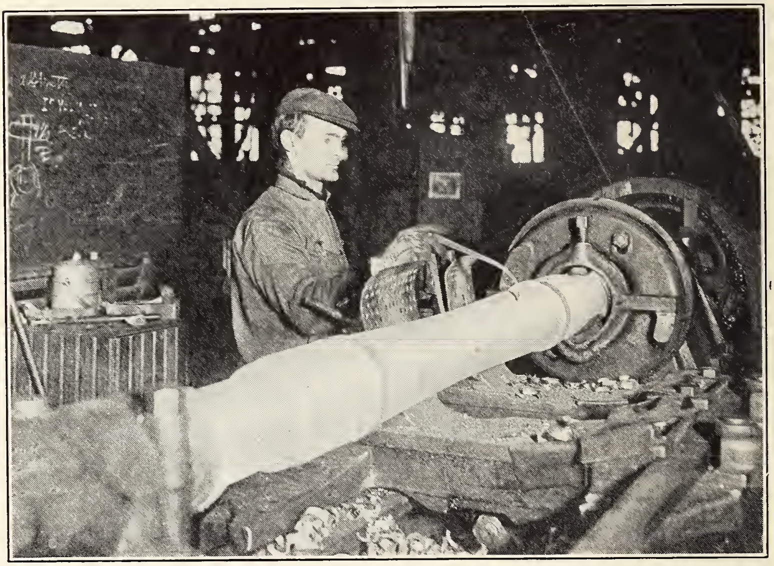

Figure 4.—An inexpensive chip deflector, made of punched sheet metal, on a lathe in one of the plants of the Carnegie Steel Company which helps to keep steel fragments out of the eyes of workmen. With careful fitting of such a guard on low speed machines it is safe for the operator to work without goggles.

The installation of trial chip deflectors in the brass bushing department of the Buick Motor Company's plants at Flint, Mich., brought such satisfactory results that they were immediately ordered placed on all bushing machines. One type of deflector, which is merely a glass window attached to the machine, turns the flying chips away from the operator into a receptacle below. Another type is made of a small piece of sheet metal that fits over the cutting tool.

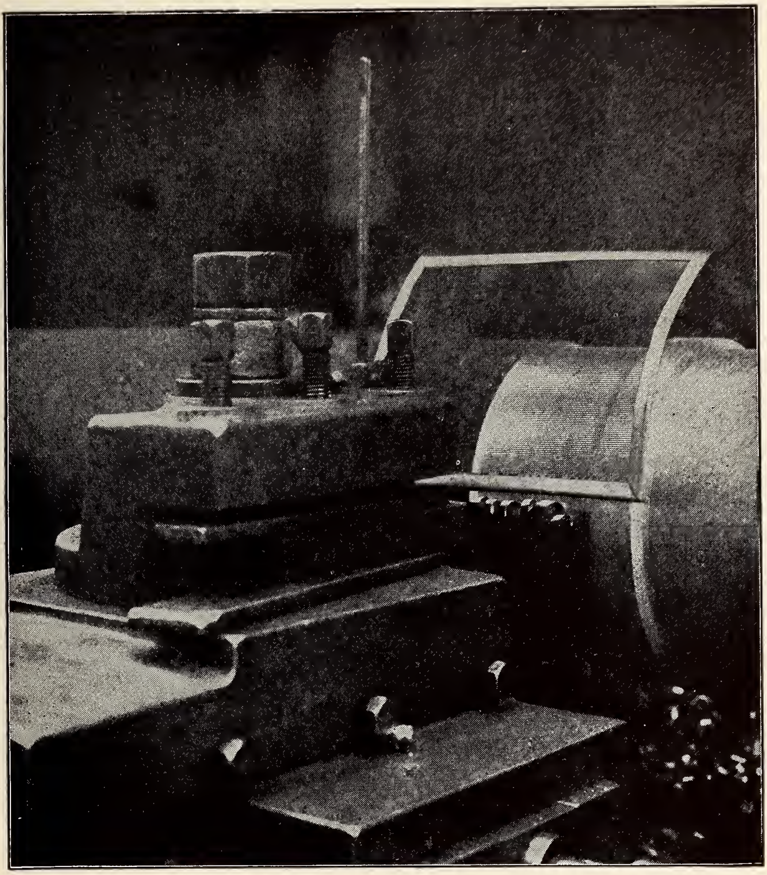

Figure 5.—A wire mesh guard which in many lathe operations provides adequate eye protection and makes unnecessary the use of goggles. In the case of high speed machining, however, it is not safe to rely entirely on this type of guard.

Courtesy the Travelers Insurance Co.

One of the simplest chip guards yet devised is being used effectively at the Inland Steel Company's Indiana Harbor plant. This is built of ordinary window screen, four inches square and set in a stiff wire frame. Two parallel wire extensions project from the screen and are anchored in the back of a left-hand glove. When a chipper uses this guard, the screen covers the area near the chisel point and deflects flying chips. Similar wire shields, attached to the end of air hammers, are used in the shops of the Duluth & Iron Range Railroad to prevent chips from striking the operator in the face.

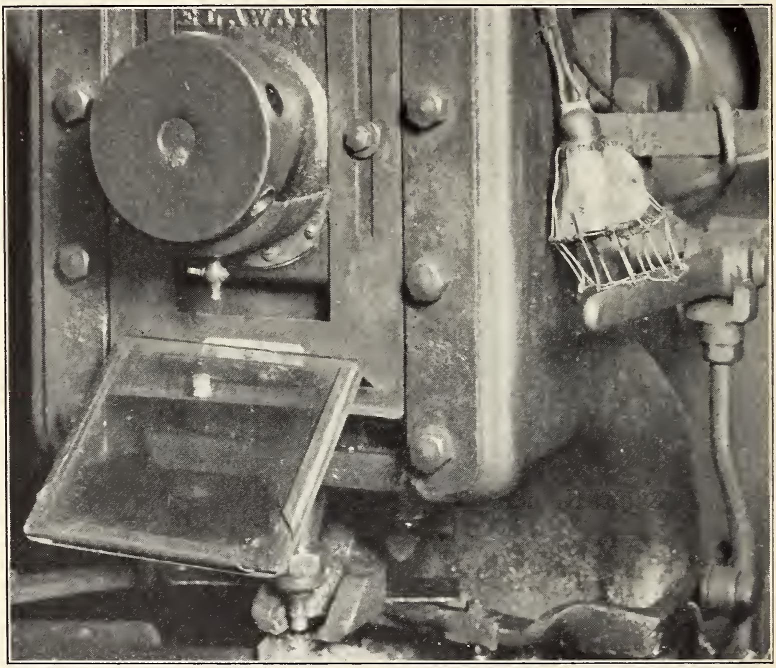

Figure 6.—A plate glass punch press guard which protects the eyes of the operator from flying metal fragments

Because of the difficulty of getting those workmen who are exposed to eye hazards throughout the day to wear their goggles all the time, more and more attention is being given to the elimination of eye hazards by guarding the machine or tool at the point of operation. This type of guarding often requires the utmost ingenuity if it is to be effective and yet not interfere with the operation of the machine or tool. It should be recognized, however, that few machine and tool guards afford as complete protection as goggles. Three types of deflectors which have come into common use in metal working plants are shown in Figures 4, 5, and 6.

Shall It Be Goggles Or Guards?

Safety is nearly always a quantitative matter. Consider the case of eye protection sought by the use of a guard at the point of operation rather than through goggles. Let us assume that the principal hazard is from particles flying from the end of the tool itself, and that there is also a slight hazard from rebounding particles or particles from some other nearby chipper. We must weigh the 100 per cent protection of the goggles (if worn), the possibility that they may not be worn all the time and the fact that they will be uncomfortable when worn, with the 90 per cent efficiency of the shield which involves no discomfort or inconvenience to the workman and is always in place. The choice between these alternatives depends entirely on the nature of the work.

It is obvious that where a number of chippers are working together and particles are flying in all directions, goggles provide the only real protection. On the other hand, under conditions where the possibility of rebounding particles is not great and where there is little or no hazard of flying particles from the tool used by some other chipper close by, shields such as are used by the Duluth and Iron Range Railroad and the Inland Steel Company provide sufficient protection. Whether to rely on shields or goggles or both should be determined in each case entirely by the conditions of the job itself. The difficulty of getting workmen to wear goggles should not enter into the decision except where unusual atmospheric conditions, such as extreme heat or the presence of steam or smoke, make goggle wearing impossible or extremely difficult. Once it has been decided that only through goggles can real protection be secured, there should be no compromising. Means of enforcing goggle rules will be discussed in a later chapter.

An instance of the prevention of eye injuries through engineering revision indicative of the fundamental nature of this form of safety work and affording a better picture of the possibilities in this direction is described by H. Walter Forster, vice-president of the Independence Bureau, Philadelphia.

> "A certain large corporation employing 3,000 men in one plant had several employes lose eyes through flying portions of tools, and the management admitted that the condition of tools generally was bad. A competent safety engineer submitted a report as to a method of controlling the hazard, but the management decided that the proposition was not feasible, or at any rate not advisable. However, after two more men had lost an eye each it seemed necessary to do something. Then the engineering report, after modifications were made by the local plant men, was put into effect.
>
> "There was absolute control of every tool at the beginning and at the end of every shift. Immediate dressing was given every mushroomed head. Edged tools had real edges. Helves and handles were safely attached and straight. Every tool was made safe and efficient. An enormous number of tools, many of them forgotten, were collected from all portions of the plant. The time certain men started to work and left was for the first time definitely known. And generally there was sufficient increase in efficiency to pay for the entire cost of the tool control. For a period of over a year after this plan of control

> was put into effect, no eye injuries took place. The accident prevention results were the by-product of efficiency. To show the completeness of control, I may say that the engineer who in the first instance examined tools reported that he looked over some two thousand articles almost all of which were defective or sub-standard. At a subsequent examination he saw almost an equal number of tools and he found only four which were not in perfect condition. Here was a concrete case where the management for a long time had been saying to foremen and workers 'do not use defective tools.' The educational attack got no results; engineering analysis and modern plant control methods did."

In this case the accident prevention results were the by-product of engineering revision for purposes of efficiency. There are on record, however, cases in which unlooked-for production efficiency was the by-product of a bit of engineering revision carried out primarily or largely for purposes of accident prevention. Thus, C. P. Tolman, while studying the possibility of eliminating dust and other hazards in the manufacture of white lead, revised a generation-old manufacturing process and thereby not only reduced accident and health hazards, but at the same time lessened the plant investment.

There are, undoubtedly, great opportunities for the prevention of eye accidents through engineering revision and through guarding at the source of flying particles. It is recommended that safety men everywhere look into the possibilities for such fundamental safety work in their respective plants. Such improvements as are made should, however, be considered as supplemental to the protection afforded by goggles and other standard head protection until the new process machine or tool has been in operation for a sufficient period to demonstrate beyond any doubt that the process is safe without the use of goggles.

CHAPTER IV

INDUSTRIAL EYE ACCIDENTS AND MEANS FOR THEIR PREVENTION

Until greater progress has been made in the application of engineering revision to the prevention of eye accidents, goggles and head masks remain unequalled as a means of preventing injuries to the eye. Great strides have been made during recent years in the development of goggles and masks. The cumbersome all-purpose goggle of five or ten years ago is seldom used now. Today there is an especially designed goggle or other form of head protection for every type of eye hazard and a sufficient variety of frames to meet almost any objection that might be voiced by the workman. But this great multiplicity of types and styles of goggles itself presents a new danger: that of using the wrong goggles for a particular hazard.

The choice of goggles cannot always be left to the workman or the foreman. Even the safety engineer cannot select goggles offhand. The exact nature of the particular hazard and the details of construction and materials of the several styles of goggles must be carefully considered. The hazards of certain industrial occupations can be safeguarded only by the type of goggles developed for that particular hazard; the use of improper goggles in such cases is often almost as dangerous as the failure to wear goggles at all. For example, certain types of goggles which provide complete protection from splashing chemicals are almost worthless as protection against flying chips of steel.

The first step in any effort to prevent industrial eye accidents should invariably be the acquiring of a copy of the National Safety Code for the Protection of the Heads and Eyes of Industrial Workers* and the placing of responsibility for the proper selection and distribution of goggles on some one individual capable of understanding the code and of applying its provisions to the local or special conditions in the individual plant.

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* Copies of this code may be obtained at a cost of ten cents from the Superintendent of Documents, Government Printing Office, Washington, D. C. It is No. 2 of the Bureau of Standards Handbook Series.

The code was developed during the fall of 1921 by the U. S. Bureau of Standards, with the assistance of an advisory committee made up of the representatives of employers, employes, state industrial commissions, and the manufacturers of goggles. The code has since then been revised and approved as "American Standard" by the American Engineering Standards Committee. This approval is a guarantee that all the interests in any way involved in the subject of the code were represented in its preparation and revision. It also insures acceptance and observance of the code by industry generally throughout the United States.

Inasmuch as succeeding chapters of this publication follow closely the classification of operations and processes developed in the national code, it is well to restate that classification here, quoting directly from the code.

Classification of Operations and Processes

The processes or operations in which it is necessary that the operator be given protection for the head or eyes, or both, are divided into nine groups, each of which requires a protector having distinctive features. The examples given for each group are illustrative only and are not intended to be complete lists of the operations or processes for which protection is necessary. These groups are as follows:

Group A.—Processes where protection from relatively large flying objects is required. Examples of these processes are chipping, calking, and some riveting operations.

GROUP B.—Processes where protection from dust and small flying particles is required.
Examples are scaling and grinding of metals, stone dressing, and some woodworking operations.

GROUP C.—Operations where protection from dust and wind is required.
Examples are automobile driving, locomotive driving and firing, and outdoor electric welding, where there is no exposure to radiant energy.

GROUP D.—Processes where protection from splashing metal is required.
Examples are babbitting, pouring of lead joints for cast-iron pipes, casting of hot metal if there is a possibility that water is present; and dipping in hot metal baths.

GROUP E.—Processes where protection from gases, fumes, and liquids is required.
Examples are handling of acids and caustics, dipping in galvanizing tanks and some japanning operations.

GROUP F.—Processes where protection from an excessive amount of dust and small flying particles is required.
An example of these processes is sandblasting.

GROUP G.—Operations where protection from reflected light or glare is required.
Examples are prolonged exposure to snow-covered ground, exposure to reflected sunlight from roofs, roadbeds, etc.

GROUP H.—Processes where protection from injurious radiant energy with a moderate reduction in intensity of the visible radiant energy is required.

Examples are oxy-acetylene and oxy-hydrogen welding and cutting; open hearth, Bessemer, and crucible steel making; furnace work, electric resistance welding, brazing, and testing of lamps, involving exposure to excessive brightness.

GROUP I.—Processes where protection from injurious radiant energy with a large reduction of the visible radiant energy is required.

Examples are electric arc welding and cutting.

The National Head and Eye Code, as it is referred to for brevity among safety men, offers the following definitions of the principal forms of material protection:

Protector.—A protector is a device which is placed in front of the eyes, face, or head to afford protection from the hazards in industrial processes or from the natural elements.

Goggles.—Goggles are an optical device worn before the eyes, the predominant function of which is protection to the eyes only.

Face Mask.—A face mask is a device worn before the eyes and a portion or all of the face, the predominant function of which is protection to the eyes and face.

Helmet.—A helmet is a rigid device worn by the operator, which shields the eyes, face, neck, and a portion or all of the other parts of the head and is held in place by suitable means.

Hood.—A hood is a device which completely covers the head, neck, and portions of the shoulders so as to exclude dust and flying particles.

Shield.—A shield is a device to be held in the hand, or supported without the aid of the operator, the predominant function of which is protection to the eyes and face.

Goggles with Corrective Lenses Preferred to Wearing Goggles Over Spectacles

Before proceeding to a discussion of specific eye hazards it may be well to clear up two matters concerning which there are conflicting opinions among practical safety men. The more important of these two controversial subjects is the question of the best method of protecting the eyes of workmen with defective vision who are engaged in occupations calling for the use of goggles. On one point there is universal agreement: that ordinary spectacles, worn for the correction of vision, do not afford sufficient protection against accident hazards to justify their use in the place of goggles. There is, however, a difference of opinion as to whether workmen who ordinarily wear spectacles should be expected to wear goggles over their spectacles or should wear goggles with corrective lenses and no spectacles.

The principal objection to the latter is that ground lenses, when broken, are more likely to fly out of their frames and into the eyes of the wearer than unground or stock goggle lenses. The principal objections to the use of goggles over spectacles are, first, the discomfort of wearing two frames and, second, the fact that under such circumstances both spectacle lenses and goggle lenses cloud easily. The objections in both cases are valid. Here again the 100 per cent protection of goggles and spectacles (if worn), together with the likelihood that they will not always be worn, should be weighed against the 90 per cent protection of goggles with corrective lenses and the greater likelihood of their being worn all the time. The objections to wearing goggles over spectacles are partially overcome by a device which has recently been placed on the market and which is illustrated in Figure 7.

This device consists of two detachable cups, equipped with standard protection lenses, which may be fitted to any spectacle frame of the type adopted by the United States government as standard during the war and consequently referred to as "the military frame." The insides of these cups are equipped with metal springs and clips which adjust themselves automatically over the spectacle frame.

Although the national code appears to give preference to the use of goggles over corrective spectacles—suggesting the use of goggles with corrective lenses as an alternative—an inquiry addressed by the National Committee for the Prevention of Blindness to a number of the leading safety engineers of the country brought replies indicating an almost universal preference for the use of goggles with corrective lenses except in the rare cases where the workman himself prefers to wear goggles over his spectacles, or in the relatively few cases where the optical prescription requires grinding the goggle lens to a dangerous thinness. In most cases, however, the slight loss of strength from grinding is more than compensated for by the convenience of wearing only one pair of goggles instead of goggles and spectacles. The most important element in eye protection by means of goggles is getting the workman to wear them; everything possible should be done, therefore, to make the wearing of goggles easy and convenient.

The official opinion of the National Safety Council, as expressed in No. 14 of its "Safe Practices Series," also takes

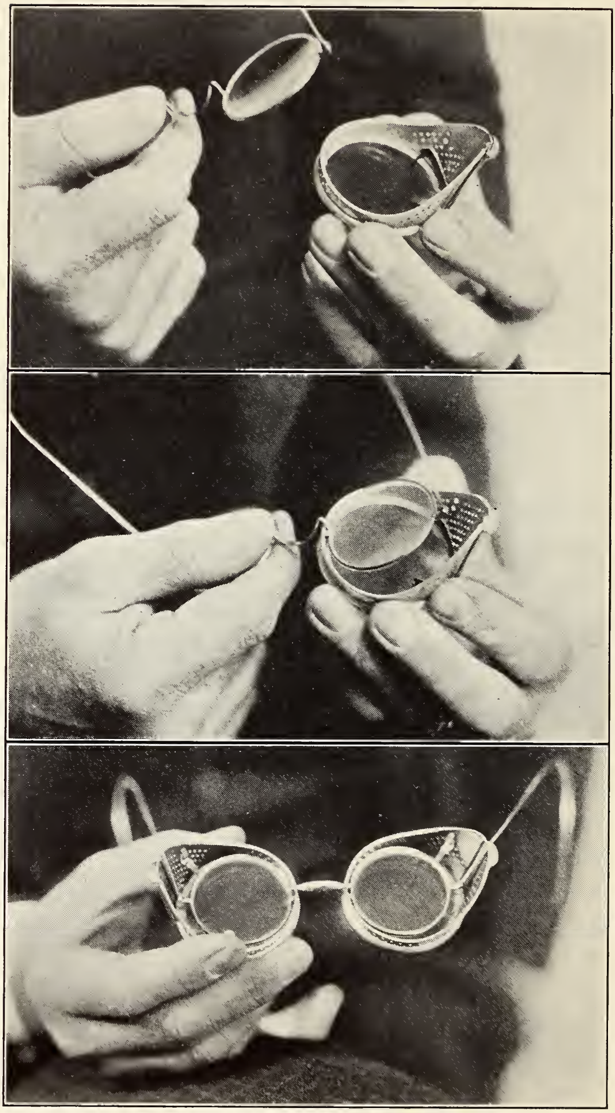

Figure 7.—Detachable goggle cups for use over spectacles.
Courtesy Willson Goggles, Inc.

this view. We read there: "Employes who should wear goggles and who are accustomed to wearing spectacles with corrective lenses should wear goggles provided with lenses ground from the same prescription, to make it unnecessary for them to wear their glasses under the goggles; or they should wear goggles with frames large enough to fit over their spectacles."

In at least one large metal working plant* this problem is being solved by the happy medium of using both corrective and protective lenses in one frame. The optical department at this plant has developed a method of mounting the corrective lens immediately behind the protective lens of a standard type of goggles, thus minimizing the clouding of lenses and, in fact, giving the workman greater protection against the blow of a flying object than the protective lens alone would give. The only objection that has been voiced against this innovation is the weight of two pairs of lenses in a single frame. In some cases at this plant the use of prescription lenses alone in goggles is allowed, and in such cases a special frame is used, and in fitting the lens into the frame every effort is made to reduce the possibility of glass leaving the frame in the event of breakage.

The second controversial subject to which we have referred, the use of laminated lenses in goggles, also revolves around the effort to keep fragments of glass out of the eyes of workmen in cases where the lens is shattered by a flying object of great weight or force. A laminated lens is one made up of two or more layers of glass or other transparent material with a thin layer of non-shatterable substance, such as mica or celluloid, placed between them. Sometimes a transparent gluing substance is used in place of mica or celluloid between the layers of glass to keep fragments from leaving the frame in case of breakage.

The argument offered in favor of a laminated lens is that it reduces or eliminates the danger of glass flying into the eyes of the wearer when the goggles are broken in service. This is a real hazard, one that has caused numerous eye injuries, but its seriousness grows less each year with the improvements constantly being made in the development both of better goggle frames and of stronger clear glass goggle lenses, as illustrated in Figure 8.

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* West Lynn (Mass.) Works, General Electric Company.

There are two serious objections to the use of laminated lenses—first, the danger of impairing the vision of the wearer and, second, the difficulty of getting workmen to wear them consistently. Heat, sudden changes in temperature, and other atmospheric conditions frequently affect the substances used between the two layers of glass in such a way as to cloud the vision seriously. This necessitates frequent changing of lenses, often at times when it is impossible for the workman to get a new pair of goggles or new lenses quickly. The resultant exasperation of workmen and foremen often develops a prejudice not only against goggles with laminated lenses, but against the whole practice of wearing goggles.

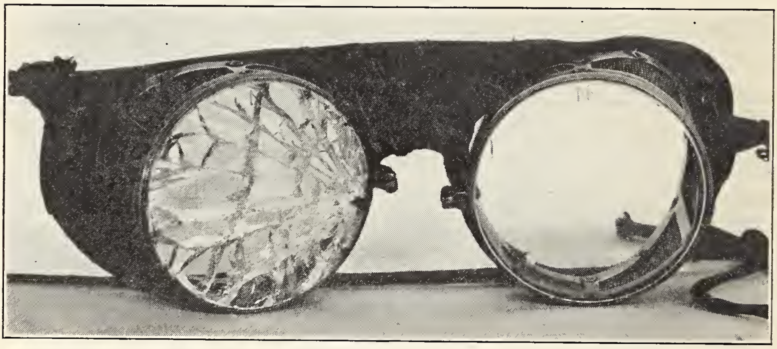

Figure 8.—Evidence of the progress that has been made in the manufacture of goggles. The lens has been shattered into scores of pieces, but not a particle of glass left the frame. It is not difficult to imagine what would have happened to the eyes of the man who wore these if he had not had them on at this particular moment.

The attitude of many safety engineers is that, granting the fact that laminated lenses eliminate the danger of injury to the eye from broken glass, they create the new danger of impairment of vision by persistent strain, and that the latter hazard is more serious than the former.

PROTECTION AGAINST RELATIVELY LARGE FLYING OBJECTS

The danger of injury to the eye from relatively large flying objects, such as rivets, nails, metal chips, concrete chips, splinters of wood and fragments from mushroomed tools, exists to some extent in practically every industry, but is most serious in certain operations of the metal industries, in quarrying, and in the construction industries—particularly in shipbuilding and structural steel work. When it is impossible in any particular operation to eliminate this hazard by changing the machine, the tool, or the method of work, protection must be sought through the use of goggles, masks or screens, depending on local conditions—often through the combination of these three media.

The extensive use of pneumatic tools in ship-building has in recent years introduced a serious eye hazard for the riveter, chipper, caulker, driller and reamer. In this industry, since it is in many cases hardly possible to use movable shields or screens, goggles and masks must be relied on almost exclusively for protection.

In the metal industries, in such operations as chipping and riveting, especially where pneumatic tools are used, heavy fragments of metal may be sent flying in any direction with great force. It is therefore essential that goggles used in such operations should have the strongest clear lenses available and should afford side protection; this may be obtained by the use of goggles with side shields.

Side shields are necessary in order that flying particles may not enter the spaces around the lens container. The shields may, of course, be solid or perforated but, if perforated, the holes should not be large enough to allow particles to enter. The frames of goggles should be of light substantial material and should fit the face closely below the eyes. The principal requirements are comfort to the wearer and strength enough to stand the service. The latter requirement is determined by a strength test of the lens containers and the frames, prescribed in the national code.

A high percentage transmission of light is of importance for this class of work. Almost any lens made of colorless glass will transmit more than 80 per cent of the incident light. Laminated lenses may not have transmission quite so high. The limit in the national code has therefore been placed at 70 per cent. A laminated lens may become cloudy when subjected to heat, depending on the material which is used between the glasses and the method of sealing the joints. Goggles with such lenses should not be used in processes where they might be subjected to high temperature. Sterilization in hot water may similarly result in deterioration.

Frames of goggles should be made of a material that will permit of sterilization and will not tarnish, rust, corrode or otherwise react chemically with the perspiration from the skin. Such reaction, if it occurred, might cause irritation or discoloration of the skin, which is of course objectionable to the worker.

The chipping or finishing of iron and steel castings and forgings probably presents the greatest of all the hazards from relatively large flying objects, both because of the great number of men engaged in such work and because of the nature of the wound usually caused by a chip from a steel casting. In practically every foundry, large or small, there is a finishing or chipping department where rough spots, adhesions and other defects are removed from the surface of the castings. Usually this work is done with powerful pneumatic chisels which send fragments of steel through the air at bullet-like speed. There is also frequent need for chipping in other

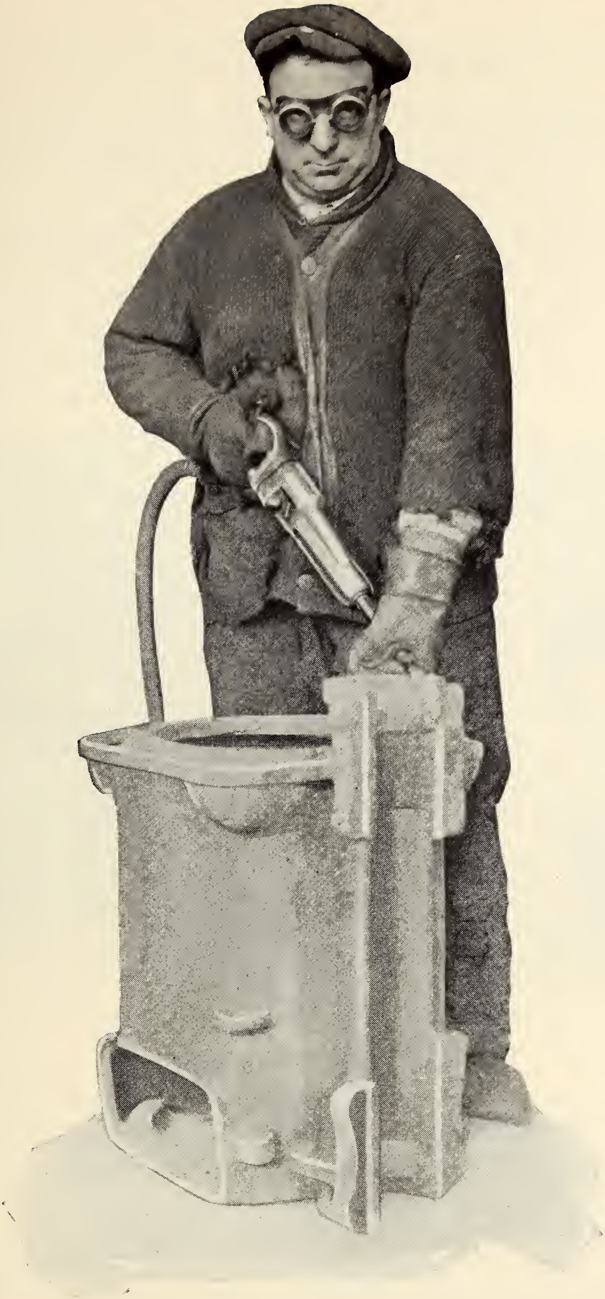

Figure 9.—Properly selected goggles and the willingness to wear them have saved this chipper's eyes sixteen times. He is an employe of the West Lynn Works, General Electric Company.

metal producing, metal working and fabricating plants. The number of men engaged in this work throughout the country probably runs into tens of thousands.

The dangers incident to the penetration of the eyeball by a fragment of steel, brass or copper are serious, such injuries often progressing to infection and loss of sight. These flying chips frequently penetrate the eyeball so deeply as to lodge in the optic nerve or in the posterior part of the eye, from which removal is extremely difficult and sometimes impossible even with the greatly improved surgical magnets now in use and the skilled technique of ophthalmologists who have specialized in industrial work.

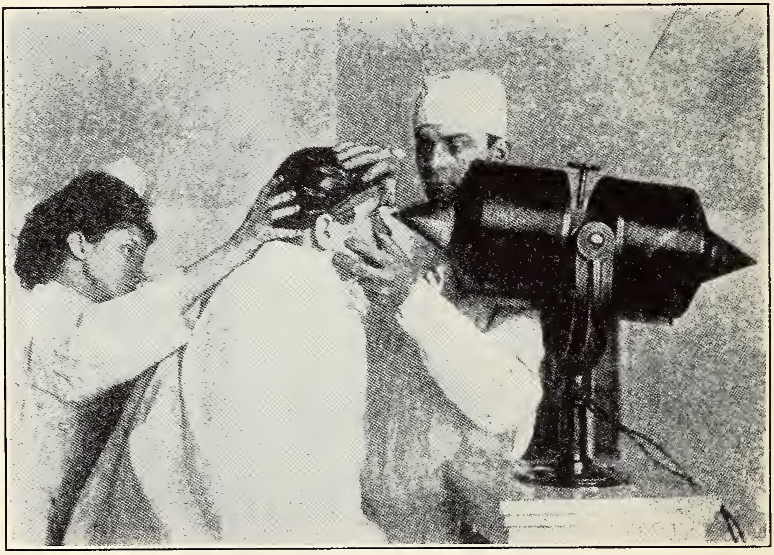

Figure 10.—Electro-magnet for removing steel chips from the eye.

An operation in the steel industry which has been one of the most prolific causes of injury of this nature is the removal of surface seams from cold steel blooms. A bloom is a roughly prepared mass of iron intended to be drawn out under the hammer or between the rolls into bars. It is an intermediate between the ingot and billet and is to be found in practically all steel mills where the process is not "universal" or continuous. In finishing a cold steel bloom the chippers frequently work toward one another from opposite ends of the bloom. A constant fusillade of steel chips is the natural result, the chips from each worker's chisel flying directly into the face of the other worker. Here is an excellent opportunity for accident prevention through a simple change in the method of work.

In the plants of the United States Steel Corporation a definite effort has been made to discover the safest position for each chipping operation and to train chippers to work in that position. In line with this practice, cold steel bloom chippers are instructed either to start from the middle of a bloom and work in opposite directions or to work in the same direction on separate blooms. In this operation suitable goggles eliminate practically all danger to the individual workman from chips from his own chisel and the judicious use of floor screens minimizes the danger of injury from the chips from the tools of other workmen. These screens may be made of a double layer of burlap or heavy canvas and should be mounted on frames which are adjustable as to height and easy to move. Wherever metal chipping is done, a supply of such screens in various sizes should be readily available and their use should be considered as imperative as the wearing of goggles, but should not in any case supplant the wearing of goggles. An inexpensive and yet effective screen may be made of wallboard as shown in Figure 11.

Safety engineers of long experience now agree that goggles should be worn in every chipping operation and that all other forms of protection should be considered supplementary. The liberal use of screens is recommended in chipping departments where workmen from other departments, plant executives or visitors may come within range of flying chips, even though such a possibility seems remote.

The eyes of many passersby have been lost in industrial plants where the goggle-wearing rule is not strictly enforced for all visitors and transients, as well as for the chippers themselves.

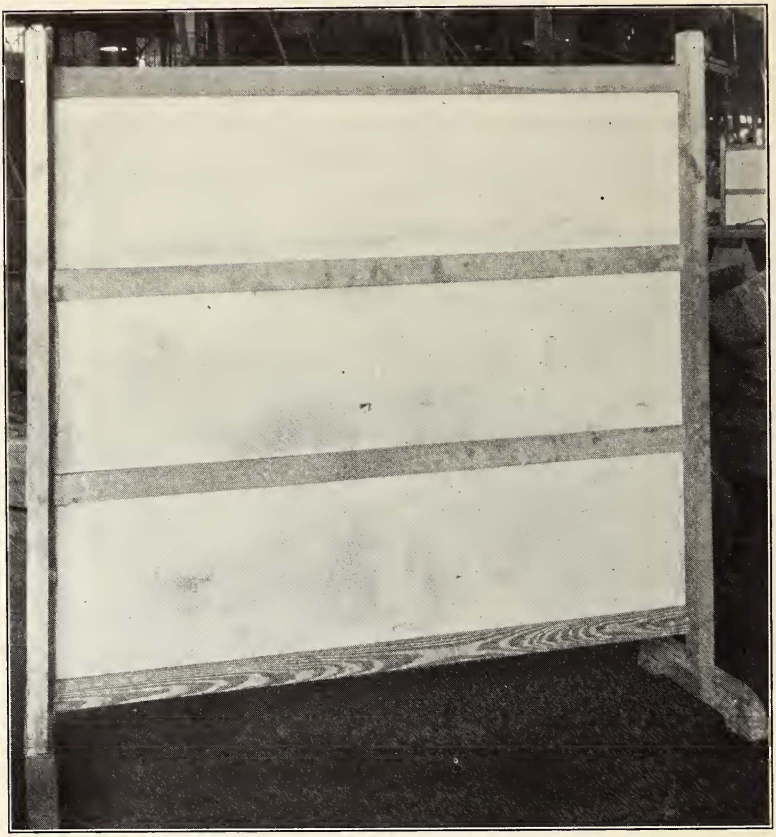

Figure 11.—The liberal use of shields in chipping departments and in other operations where there is the danger of metal, concrete, or wood fragments flying over long distances, is essential for the protection of passing workmen.

Another device that has been used with great success, particularly where chipping is done by a hand chisel rather than by a pneumatic tool, is a wire screen about six inches square supported by a wire frame and attached to the left-hand glove of the chipper. Such a screen will stop the flight of all ordinary chips in hand chiseling but is not likely to be effective with a pneumatic tool.

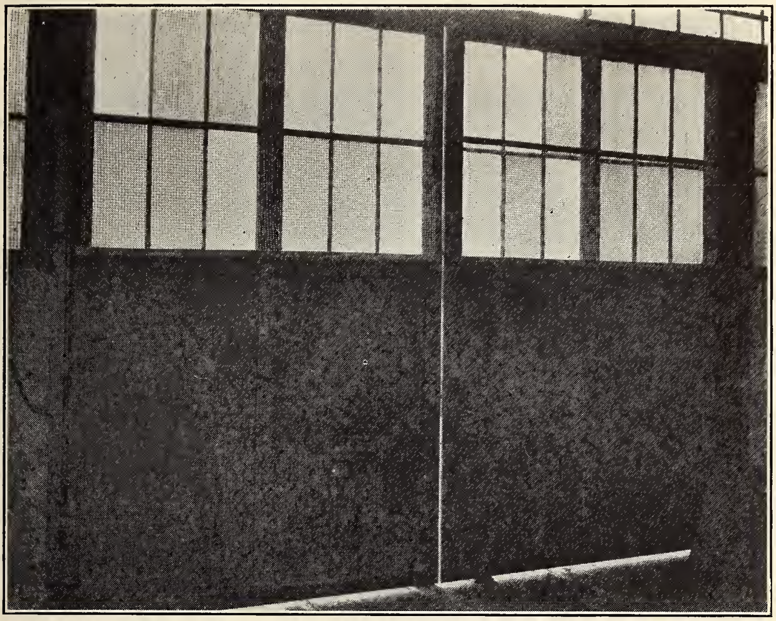

Figure 12.—Heavy wire screening used over windows in riveting, chipping, and dismantling departments of the Pullman Company for the protection of passers-by.

Protection Within the Rolling Mill

In the rolling mill, two classes of men need to be protected from the principal eye hazard, the shower of flying scale thrown off each bloom during the first few passes between the rolls or under the hammer. The first of these classes are the "rollers," the men who operate the rolling machines and who stand in what is known as the "pulpit," an elevation immediately behind the rolls. Complete protection for these men may be secured by the construction of a plate glass shield, preferably one of wire glass, in front of the pulpit or platform.

The second group of men who need to be protected from flying scale are the workmen who stand beside the rolls to pry loose blooms that have become wedged or otherwise unruly. In the past these men have been—and in some plants still are—protected from flying scale by masks made of fine mesh wire. It has, however, been discovered that constant use of the wire mesh mask causes eye strain, which in the long run is almost as serious as the hazard from flying scale. Recently there has been designed a light-weight fiber mask with ordinary goggle lenses which is now in quite general use at this operation in plants where complete protection is sought.

A goggle code developed at the American Steel and Wire Company and recommended to all the subsidiary companies of the United States Steel Corporation by its Bureau of Safety, Sanitation and Welfare makes the wearing of goggles compulsory in the chipping of iron, steel and other metals in all departments, in chipping castings, in chipping cinders from heating furnaces, in chipping brick or concrete, and in chipping scale from drums in boiler houses. A summary of this code will be found in Appendix II.

The Hazards of Riveting and Rivet Removing

The eye hazard inherent in reaming, riveting and rivet removing in such occupations as building construction, shipbuilding, boiler making, car building and dismantling of ships, cars or structural steel work is not so serious as the chipping hazard in point of view of frequency, but is perhaps more serious in terms of severity.

While this hazard also has been intensified by the use of powerful pneumatic tools, this is compensated for by the fact that the increased efficiency of such tools has cut down the number of men needed and, like the automatic machine, has in this respect proved to be a safety measure.

In riveting, the valve in the air hammer occasionally sticks or breaks, and when the hammer is removed from the rivet the plunger may fly out of the tool and strike the bucker in the face. Recognizing this danger, many buckers take the precaution of turning their faces to one side, particularly when the hammer man is driving upper cut rivets. This, however, is only partial protection; moreover it interferes seriously with the efficiency of the operation. Much more effective for the prevention of this type of accident are the arresting devices with which many modern pneumatic tools are now equipped to hold the plunger in place when a defect in the valve develops or when the trigger is touched accidentally while the air is on.

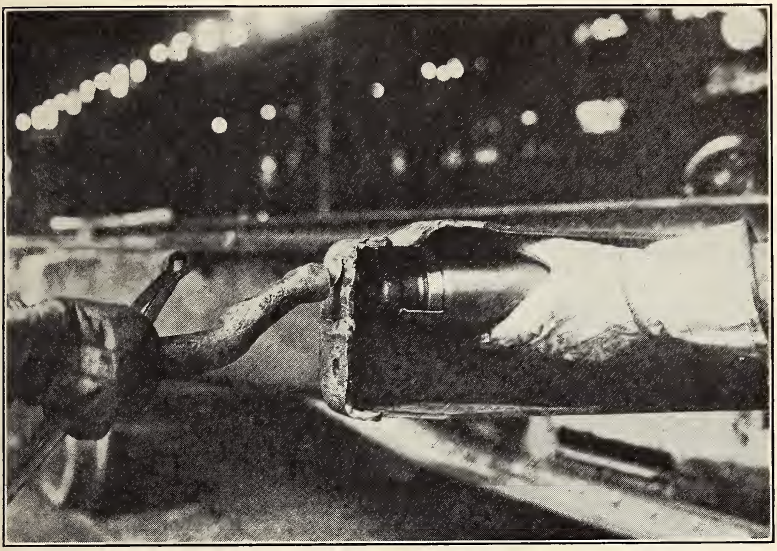

Figure 13.—The practice of covering only part of the rivet head with the dolly-bar is unsafe, as the bucker may be shot by the rivet jumping out of the hole when the force of the hammer is applied.

The practice of some buckers of covering only part of the rivet head with the dolly-bar, as shown in Figure 13, in the expectation that jarring of the hammer will bring the bar completely over the rivet head exposes them to considerable danger. The rivet head should always be entirely covered, for if it is not, the bucker may be shot by the rivet jumping out of the hole when the force of the hammer is applied.

The cutting of rivet heads in breaking down boilers, steel cars, ship plates or structural steel work is considered by many safety engineers to be more hazardous than the operation of riveting itself. In cutting off rivet heads with the high powered pneumatic chisels in use today, the great force applied often sends the rivet head flying through the air with great velocity, thereby endangering not only the rivet cutting gang but all workmen within a range of perhaps one hundred yards or more. It is frequently necessary for

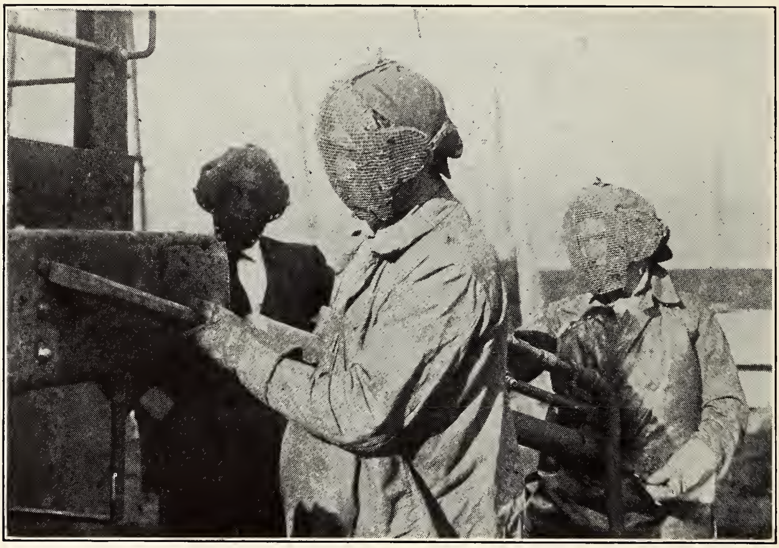

Figure 14.—Mask for men engaged in rivet cutting. Goggles alone do not afford adequate protection in this operation, because the powerful pneumatic chisels used today often send rivet heads flying with such force as to break the best goggles available.

several groups of men to cut rivets while working in close proximity. Under such circumstances neither goggles nor ordinary head masks provide sufficient protection. There has been developed for this purpose in the plants of the Pullman Car Company and in the American Car and Foundry Company, a mask similar to a baseball catcher's mask except that there are no large openings for the eyes. This mask, as will be noted in Figures 14 and 15, is made of very substantial wire mesh and the eyes are further protected by an inner mask of finer wire mesh. Since such work is nearly always done outdoors and does not require close application of the eye, the wearing of such masks is not likely to cause severe

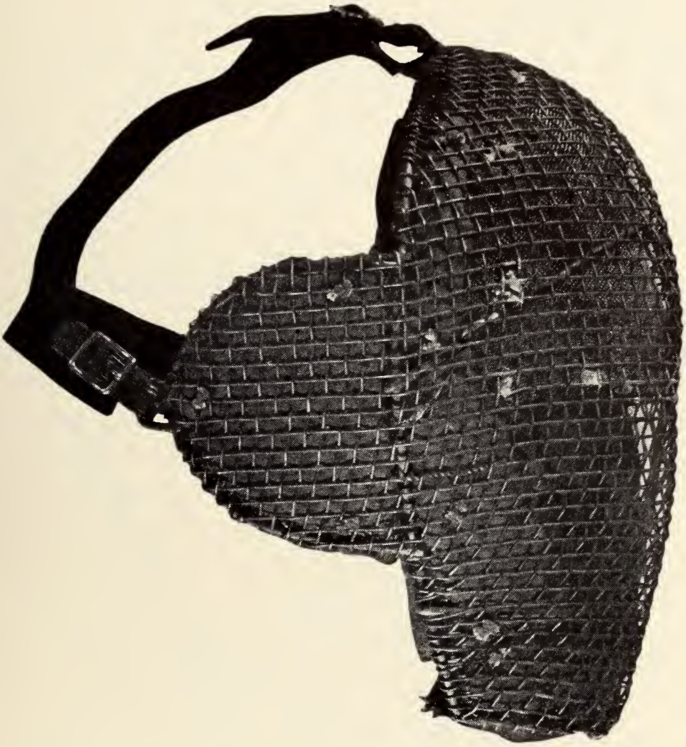

Figure 15.—Detail of rivet cutter's mask used in shops of The Pullman Company and The American Car and Foundry Company.

eye strain if sufficient rest periods are allowed. These rest periods should be increased considerably if the work is to be done indoors or under poor lighting conditions outdoors.

In some plants a catcher consisting of a wire basket attached to the end of a long handle held by the cutter's helper is used to catch rivet heads. In many plants the old practice of using brooms for this purpose is still permitted. These are very uncertain means of prevention and, sooner or later, result in serious accidents; they should therefore be abolished.

A Year Without a Compensable Eye Accident

In this operation the use of movable screens is of great value, but because of the weight and force of the flying rivets or rivet heads these screens should be of strong metal. The combination of screens and masks has practically eliminated this type of accident from the car manufacturing and dismantling plant of the Pullman Car Company, at Pullman, Illinois, and was an important factor in the safety campaign which enabled this plant, with an average of 9,500 workmen, to operate an entire year* without a compensable eye accident as against a record of eight eyes lost and $12,000 paid as compensation for eye injuries during the previous year, when only half as many workmen were employed.

Where the hazard of relatively large flying objects is not intensified by extraordinary force behind the object as in the case of flying rivet heads, a strong pair of goggles should provide sufficient protection. There is on record the case of a pair of goggles that stopped a sixteen pound sledge, the only injury to the workman being a cut on the nose and a slight bruised ring around the eyes.

Figure 16 shows an eleven ounce chip of steel which struck a pair of goggles protecting the eyes of a workman in one of the plants of the General Electric Company; what happened to the goggles is evident. Although the eye-cup was crushed in, the workman's eyes were not injured. It is not difficult to imagine what would have happened if the workman had not been wearing goggles at this particular moment. And this is not an uncommon case.

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* May 1, 1922, to May 1, 1923.

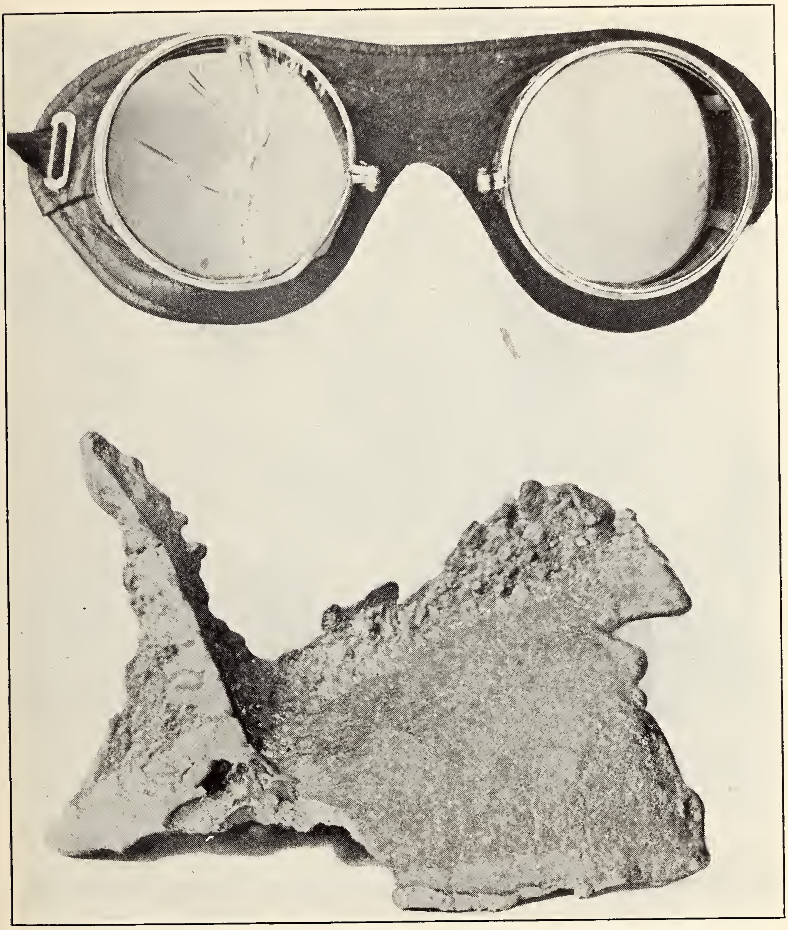

Figure 16.—Goggles with laminated lenses and the eleven ounce chip from a steel casting which struck them with such force as to stun the wearer, and crush the metal eyecup. The glass did not leave the goggle frame, and the workman's eyes were uninjured.

Eye Hazards in Metal Working Machine Operations

Operations involving the cutting or turning of metals on machines produce flying chips which are a source of many eye injuries. This danger must always be taken into account in the tooling of brass, cast iron, and high carbon steel. These metals, being hard and brittle, are likely to be the source of flying chips, particularly when tooled at high speeds. In the machining of rough castings there is also the danger of sand from the molds, which has adhered to the metal, being

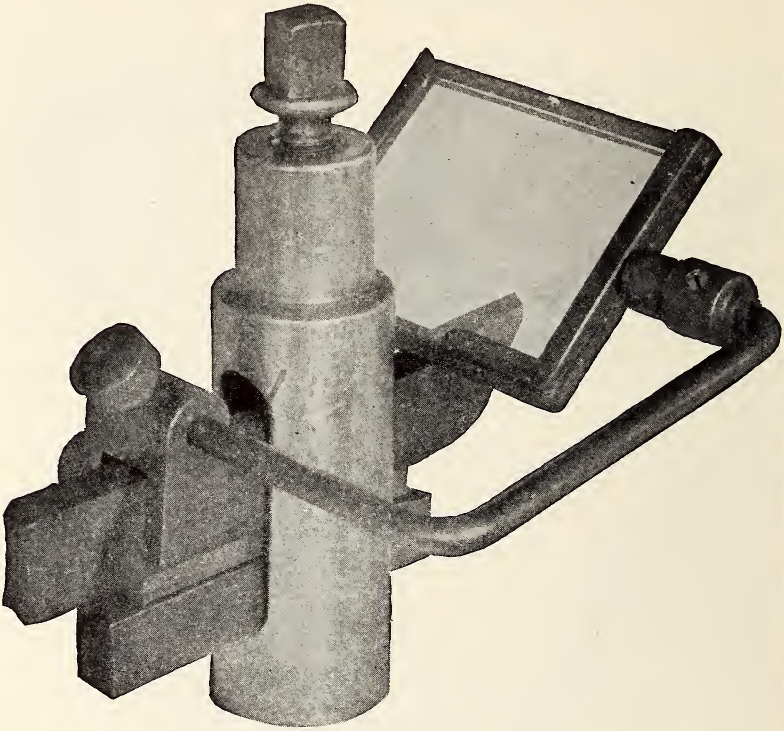

Figure 17.—A plate glass eye-shield as applied to a tool post. This device gives the workman full view of and accessibility to the tool and the material being worked while protecting his eyes from flying particles. *Courtesy The Travelers Insurance Company.*

thrown into the eyes of nearby workmen or passersby. This often proves as great a menace as flying chips of metal. Because machine tooling is nearly always precision work requiring close attention, it is particularly desirable to make every effort to eliminate the eye hazard at the source rather than through the wearing of goggles. This is nearly always possible through the use of some sort of protective guard on the machine itself at the point of operation. The designing and installation of such guards should not, however, be left to the workman, although his advice should be sought, if for

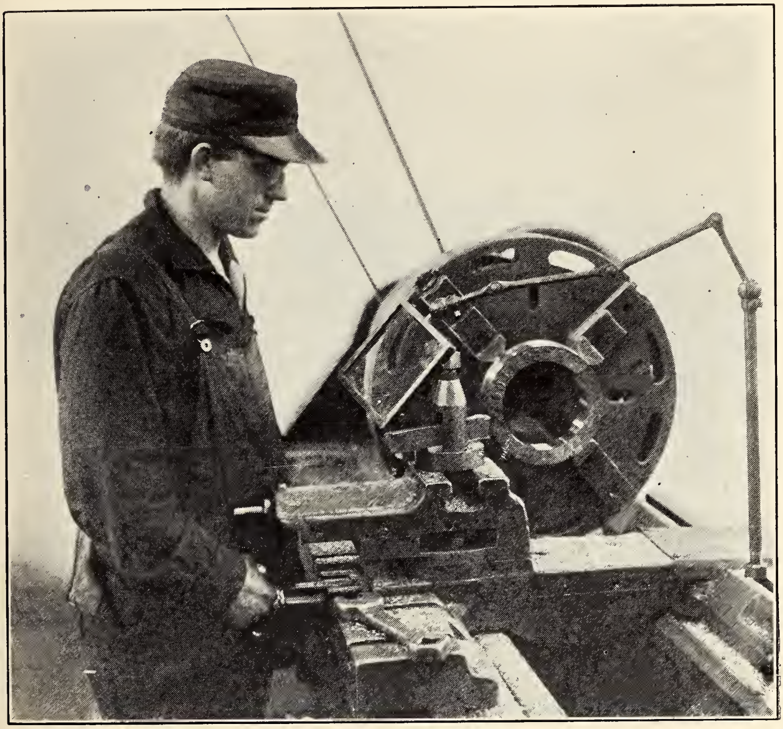

Figure 18.—Glass chip-shield on lathe. Shield is supported by a universal jointed arm secured to tool carriage, so that it can be readily adjusted.

no other reason than to encourage proper use of the guard after its installation. In some cases, guards placed on or near machines by workmen themselves have caused rather than eliminated accidents. Any competent safety engineer or—in the plant too small to afford a safety man—master mechanic, superintendent or foreman should be able to devise a properly designed guard for any shaper, lathe, milling machine, drill or other machine tool. The guard should be made of substantial material, usually sheet metal or plate glass, and carefully fitted to the machine in such a way as to intercept flying chips and yet not interfere with the normal operation of the machine. Such guards are shown in Figures 17 and 18.

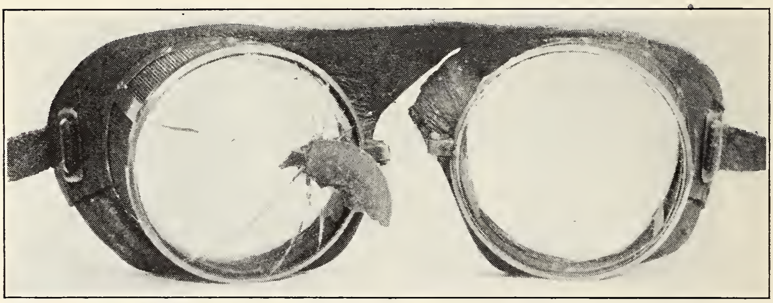

Figure 19.—A vivid instance of how goggles saved a worker from certain serious eye injury. A pointed piece of a space washer from an emery wheel dresser broke and pierced the glass of a pair of goggles but did not touch the wearer's eye.

Where the nature of the operation is such as to make impossible the development of a machine guard which will effectively stop all chips, goggles should be worn. Great care should be taken to provide goggles that will not interfere with the vision of the workman. In the shops of the United States Steel Corporation the wearing of goggles is made compulsory in the machining of tools, steel, cast iron and brass, whenever a chip guard is not in use.

The danger from sharp chips thrown off by many machine tools and an instance in which a pair of goggles saved an operator from certain serious injury are illustrated in Figure 19.

Goggles for Quarry Men

The use of goggles is not so prevalent among quarry men as it should be. Consequently, many abrasive and penetrative wounds of the eye are occurring in the industry as a whole, although the frequency of such accidents is usually not great in an individual plant. Since the eye hazard is not the most serious accident hazard in this industry, many workmen and supervisors do not give the subject of eye protection the consideration that it deserves. Men in this industry are more often permitted to purchase their own goggles than in industries where the eye hazard is recognized as one of the most serious accident hazards. The result is that substandard or improperly selected goggles are often used.

PROCESSES WHERE PROTECTION FROM DUST AND SMALL FLYING PARTICLES IS REQUIRED

Such occupations as the scaling and grinding of metals, stone dressing, and some wood-working operations present constantly the hazard of injury to the eye through irritation from, or the actual imbedding of, minute flying particles. Statistics compiled by the casualty insurance companies indicate a large increase during recent years in the number of accidents resulting from the operation of emery wheels, grindstones and other abrasive media. This is undoubtedly due to the constantly increasing use of abrasive materials. Grinding wheels have come to be used in large numbers for a great variety of purposes in many industries and they are being continually introduced as substitutes for other machining tools, both for rough dressing and for the finishing of machined parts. The rapid increase in the number of accidents resulting from the operation of abrasive wheels emphasizes the necessity for greater attention to three things: the condition of all grinding apparatus, the methods of operation and—most important of all—means of insuring the wearing of goggles at all grinding operations not thoroughly guarded by shields or other protective equipment.

Abrasive Wheels Cause 31 Per Cent of All Injuries

The analysis of more than 32,000 injuries among the records of the National Council on Workmen's Compensation Insurance shows that abrasive wheels produced 10,210 eye injuries, or 31 per cent of the total injuries of all sorts requiring medical aid. This does not mean that the abrasive wheel is the most dangerous machine in industry; it is merely a reflection of the fact that there are perhaps more abrasive wheels in operation in the United States than any other machine of high eye accident frequency.

Every factory is equipped with one or more abrasive wheels. The so-called emery wheels and grindstones are the types most commonly used. The word "emery" is frequently more or less of a misnomer, as many abrasive wheels classified under that name are made not of emery but of such products as alundum, carborundum, or crystolon. A copy of the National Code for the Use, Care and Protection of Abrasive Wheels should be a part of every safety engineer's reference shelf.

The eye hazards incident to emery grinding are threefold: first, emery dust from the wheel itself; second, fine particles from the metallic surface which is being ground; third, flying parts of an abrasive wheel which has been broken while revolving at great speed. Goggles do not provide sufficient protection against the hazards of exploding wheels; safety lies largely in preventing the explosion. Fortunately, however, the greatest hazards in connection with the use of abrasives, those of flying particles, can be entirely eliminated by the use of proper goggles.

The goggles used for scaling and grinding are not subjected to severe blows, for the particles which are thrown off in this work are usually small and not of great force. Particles may be directed at an angle to the line of sight, and for this reason it is desirable to use lenses whose dimensions are at least 1.5 inches (38 mm.) in the vertical direction and 1.75 inches (44.5 mm.) in the horizontal direction.

Ordinarily, goggles for grinders need not be of the heavier type. The thickness of the lens should be based on the kind of grinding in which the workman is engaged. Where the operator may be required to grind during all or a greater part of the day, it is of course essential that every possible effort be made to reduce the discomfort of goggle-wearing. In permitting workmen to wear light-weight thin-lens goggles there is, however, this great danger: the grinder may have occasion to do a bit of chipping or some other work where the hazard of relatively large flying objects exists and he may rely on his grinding goggles for protection, often with disastrous results. Or a grinder may make the mistake of offering his goggles to a chipper or other workman engaged in an operation requiring more substantial eye protection. Because of these dangers, some of the larger industrial concerns are standardizing on chippers' goggles for all operations where goggles are required—excepting where colored lenses or protection against splashing acid is necessary—thereby giving maximum protection to all workmen. The great advances that have been made in the design and construction of goggles justify this practice, because chippers' goggles of today are lighter and more comfortable than grinders' goggles of a few years ago.

Although exhaust systems, glass shields and other modern protective methods have reduced to a great extent the eye hazards of grinding wheel operations, this work is still such a prolific source of eye injuries that the wearing of goggles in all grinding operations is now compulsory in practically all plants where a serious effort to eliminate accidents is being made. An exception is made in certain kinds of wet grinding where the point of contact between the grinding wheel and the work is always under a stream of water which has sufficient mass and velocity to carry down into the tank of the grinder any particles which otherwise might cause eye injuries.

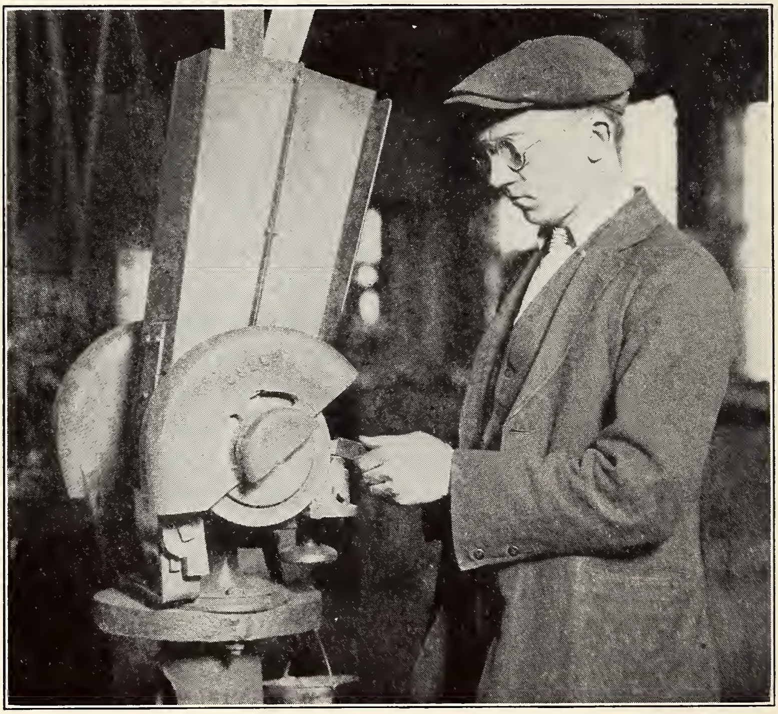

Figure 20.—A pair of light-weight, but substantial goggles should be supplied gratis or at nominal cost to each workman who has occasion at any time to use a grinding wheel.

A light, convenient case for carrying goggles should be provided. This is especially important for men using emery wheels because most workmen do not yet appreciate the seriousness of this hazard and so are likely to leave their goggles in lockers because of minor inconveniences.

As soon as the glass has become seriously pitted from the flying emery particles, new lenses should be inserted, so that the worker's vision may not be interfered with.

Flying emery particles are white hot. When they strike the eyeball they are likely to burn their way into the tissues, making removal more difficult. Although the great heat may cauterize the edges of the wound, there results an abrasion which makes it easy for harmful germs to enter and bring about serious infection.

The amount of foreign matter kept out of the eyes of grinding wheel operators and the high temperature of these particles when they are flying straight to the eye are well illustrated in Figure 21, showing a pair of goggles which were used just a few months by an emery wheel operator, with particles of emery fused fast to the lenses. These pitted glasses are an excellent indication of what would be the result upon the delicate surface of the eyes were not the protective goggles in continual use.

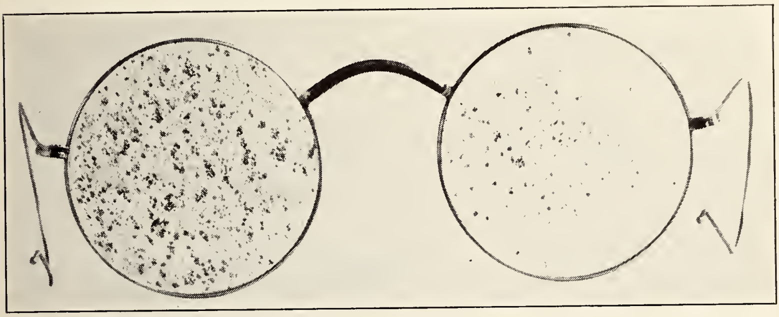

Figure 21.—These pitted goggles, with particles of emery fused fast to the lenses, became like this in only a few months' use. They illustrate how much foreign matter goggles keep out of the workman's eye and the high temperature of these particles.

It is difficult to believe that a workman who has seen such a pair of goggles would ever attempt to use an emery wheel, even for a moment without goggles, if a clean comfortable pair were available; yet few plants have taken the trouble to post such a pair of pitted goggles on the safety bulletin board or in some other conspicuous place where every workman who ever has occasion to use an emery wheel would see them.

In numerous plants, including many that are very progressive in industrial accident prevention, there is still the bad practice of hanging one pair of goggles on a nail beside the grinding wheel for the use of all men who may have occasion to operate the wheel. Even were the workmen to accept such a promiscuous interchange of goggles, the communicable diseases of the eye which would sooner or later be spread through the department if any one man in the department happened to be infected, would cost far more in time lost, in compensation for industrial diseases, ill will, and interrupted operation than it would cost to give every workman in the plant a pair of the most expensive goggles available. In many plants workmen simply refuse to wear the single pair of goggles intended for common use, and in such plants this practice results sooner or later in a bad eye accident.

The employer who wishes to be sure that he is attempting to eliminate eye hazards in the most economical and yet most efficient way will supply a pair of substantial goggles to each man who has occasion to use the grinding wheel, even if such occasion arises only once in several weeks. The common roller towel has been driven out of existence by legislation because it was such a great source of spreading communicable diseases. The time will come when the community goggles, the goggles on a nail at the side of the emery wheel, the goggles in the cigar box, also will be exiled by legislation. In well-conducted plants such goggles have been voluntarily eliminated forever.

Protective Devices Other Than Goggles

It is natural that in considering means of eliminating eye injuries in grinding and similar operations, goggles should be thought of first. But this is not the only possible means of protection. The practice of preventing eye injuries by engineering revision, rather than by the wearing of goggles, can be most easily and most effectively applied to grinding operations. The proper use of such things as glass shields, metal hoods and ventilators in combination has in many plants almost completely eliminated the danger of eye injuries in grinding operations. The plants of the Ford Motor Company and various subsidiaries of the United States Steel Corporation, not to mention other companies, provide innumerable examples of the possibilities in this direction.

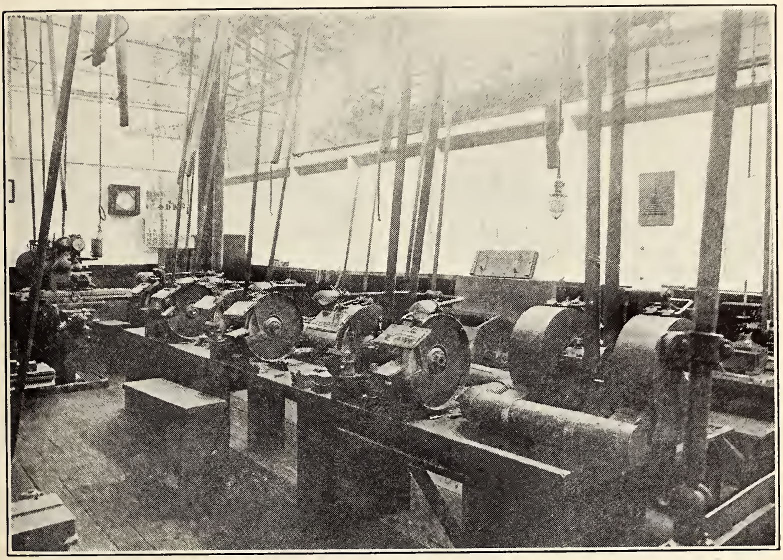

Figure 22.—A well protected battery of emery wheels, each equipped with plate glass shield and dust remover which leaves exposed only a few inches of the wheel. Localized lighting, unshaded lamps, and unguarded belts, however, detract from the otherwise safe condition of this shop.

Figure 22 shows a battery of emery wheels, each equipped with a plate glass shield and with a dust-removing installation which leaves exposed only a few inches of each emery wheel.

Considerable prejudice against the use of glass shields on emery wheels has been developed among both workmen and foremen in many plants. The principal objection voiced by men opposed to the use of such shields is that workmen, in grinding at wheels so equipped, will not watch the work being ground through the glass shield but will look around the shield or, where it is possible, will shove the shield itself to one side. Investigation has shown that the real cause of this prejudice in most cases is not the shield itself, but either neglect in its up-keep or improper installation. It is unreasonable to expect workmen to look through a glass shield which has become densely pitted with fused emery particles, or covered with a week's or month's accumulation of dust. In the many cases where one emery wheel is used by a number of men, it is unreasonable to expect any one workman to take the trouble of cleaning the glass shield. Nor can the workman be expected to use a shield which is so installed as to make it difficult for him to hold in place the material to be ground.

In plants where definite provision for keeping glass shields constantly clean has been made and where the shields have been so installed as to give the grinder all the room necessary, they are not only used but are much preferred by workmen as an alternative to the wearing of goggles. Where an emery wheel is used continually by one workman and where conditions in the shop and the quality of labor are such as to insure discipline, this problem may be solved by requiring each grinder to clean the glass shield on his own wheel at definite periods, preferably daily. Where a glass shield is installed on a wheel used by an entire department or a small number of men, or where the individual grinder cannot be relied upon to keep the glass shield clean, this responsibility should be placed on the shop cleaning force or on some maintenance worker such as an oiler. The definite placing of this responsibility, followed by frequent inspection, should insure the proper maintenance and the conscientious use of glass emery wheel shields.

The frames of glass shields should be such as to make for easy replacement of broken or pitted glass. The cost of such replacement may be reduced by using two layers of glass in the shield—a plate glass for the side nearest the workman and a thin, inexpensive ordinary window glass on the under side.

The installation of efficient exhaust systems involves considerably more expense than the installation of glass shields, but such systems in practically every case pay for themselves over and over again in the reduction of the compensation cost of eye injuries, in the increased efficiency of the workmen, and—in some cases—in the salvaging of the metal recovered by the exhaust system. Several varieties of such installations are shown in Figures 23 and 24.

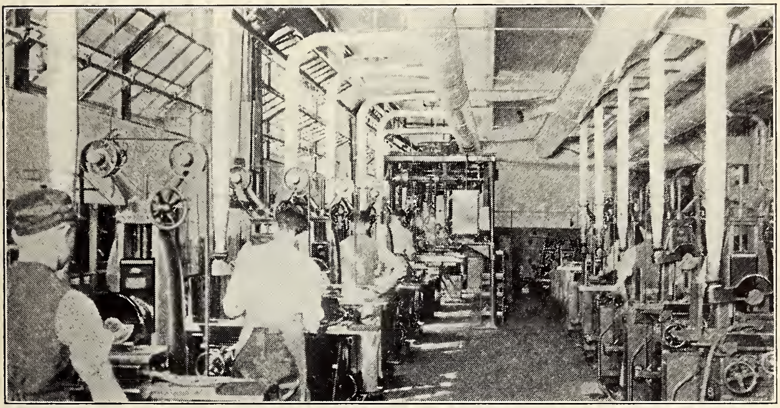

Figure 23.—A more modern installation of exhausts and emery wheel guards.

It will be noted that in Figure 24, where a glass shield is not in use, the workman is wearing goggles notwithstanding the fact that the strong suction of the exhaust system is pulling the stream of emery and metal particles away from him.

The goggles in this case are intended to protect the workman in the event of a momentary failure of the exhaust system or of an explosion of the emery wheel. It will also be noted that the wheel itself is so guarded by a substantial hood extending well below the center of the wheel as to minimize the hazard to the workman in the event of an explosion of the wheel.

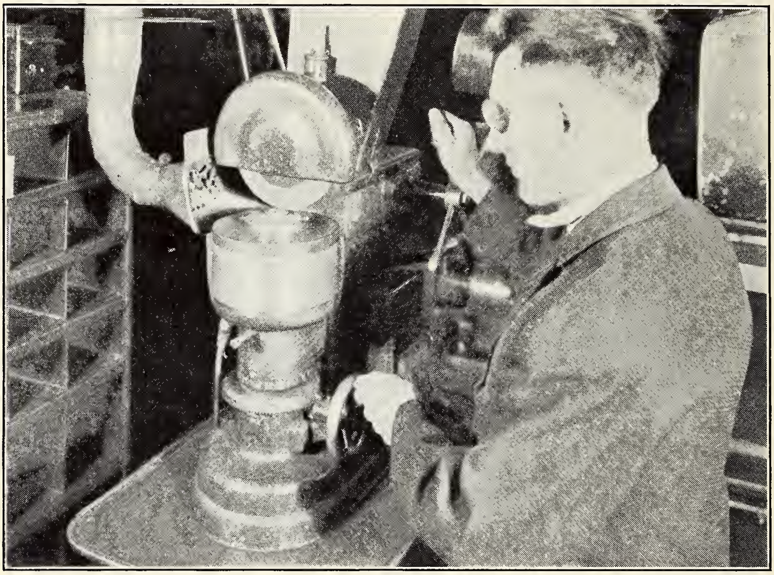

Figure 24.—The dust particles of both emery wheel and the metal being ground are carried away by the strong suction of an exhaust system; a substantial hood, extending well below the center of the wheel, protects the workman against the danger of explosion of the emery wheel; and goggles protect him against the possibility of a momentary failure of the exhaust system.

This is an instance of 100 per cent safety in the operation of a machine which in many plants is proving to be one of the most hazardous and most expensive causes of eye injuries.

Operators of machines which are as thoroughly guarded as those shown in Figure 22—by hood, exhaust system, and glass shield—should not be hampered by the requirement to wear goggles. Some plants give the man who works at the grinding wheel the choice of wearing goggles or of using a glass shield. In the installation of glass shields at emery wheels, a consideration of the nature of the work will determine whether a greater degree of safety will be obtained by a rigid or non-movable shield or by an easily adjusted universally jointed shield.

Hoods are essential to the proper equipment of grinders, not only to prevent the flying of broken parts in case of rupture, but also to protect the eyes and lungs of the operators from dust. Some employers and foremen object to providing hoods and offer various excuses, the most common being that hoods interfere with the work. In most cases the difficulties are greatly exaggerated or purely imaginary: most employers are now convinced that the output is not lessened by the use of suitable guards.

The hood should be substantially built and of such design and strength as to retain the parts of a wheel which may break while revolving at great speed. The wheels should be entirely contained within the hood except for such portions as the nature of the work actually requires to be exposed.

If for any reason it is impractical to equip the wheel with a hood, safety flanges should be used. These bind the wheel on either side, and are adapted for either straight or tapered wheels. In the event of a rupture of the wheel, the parts are clamped by the flanges. The entire surface, however, is not covered by the flanges, and for this reason the protection afforded is not so complete as that given by a hood. The use of both flanges and hood will give the maximum protection.

Flange Requirements of National Code

The general requirements for flanges in the national code are summarized as follows: All wheels excepting those which are mounted in chucks shall always be run with flanges. All tapered flanges over ten inches (10″) in diameter shall be of steel, or other material of equal strength. All other flanges may be made of cast iron, or other material of equal strength. Flanges shall be finished all over, correct to dimensions and in balance. The requirement for balance does not apply to so-called balancing flanges which are purposely made out of balance. Both flanges, whether straight or tapered, in contact with the wheel, shall be of the same diameter. Each flange, whether straight or tapered, shall be recessed at the center at least one sixteenth ($\frac{1}{16}$) of an inch on the side next to the wheel for a distance as specified in the respective tables of dimensions for straight and tapered flanges. The inner flange shall be keyed, screwed, shrunk, or pressed onto the spindle, and the bearing surface shall run true and at right angles with the spindle. The bore in the outer flange should be not more than .002 inch larger than the spindle. Protection flanges shall always be used with wheels six inches and larger which are not provided with protection hoods, chucks, or bands. Tapered protection flanges shall always be used with tapered wheels having the same degree of taper, which should be at least ¾ inch per foot for each flange. Where no hoods are used, the dimensions of taper flanges shall not be less than shown in Table V.

The national code also contains provision for and explanation of the use of protection bands and protection chucks in cases where protection flanges are not used.

NOTE.—Copies of the National Code for the Use, Care and Protection of Abrasive Wheels may be obtained from the American Engineering Standards Committee, 29 West 39th St., New York City, or from any of the grinding wheel manufacturers who are members of the Grinding Wheel Manufacturers' Association of the United States and Canada.

TABLE V.—TAPERED FLANGE DIMENSIONS IN INCHES

Diameter of Wheel in Inches	Minimum Outside Diameter of Flanges	Radial Width of Bearing Surface		Minimum Thickness of Flange at Bore		Minimum Thickness of Edge at Recess		Maximum Flat Spot at Center of Flange	Approximate Diameter of Flat Spot or Hub of Wheel
		Minimum	Maximum	For Double Taper Wheels	For Single Taper Wheels	For Double Taper Wheels	For Single Taper Wheels		
6	3	1/4	1/2	3/8	3/8	3/16	3/16	0	1
8	4	5/16	5/8	3/8	3/8	1/4	1/4	0	1
10	5	1/2	1	1/2	1/2	1/4	1/4	0	2
12	6	1/2	1	5/8	5/8	5/16	5/16	4	4 1/2
14	8	5/8	1 1/4	5/8	3/4	3/8	3/8	4	4 1/2
16	10	3/4	1 1/2	5/8	7/8	3/8	7/16	4	6
18	12	1	2	3/4	1	1/2	9/16	4	6
20	14	1 1/4	2 1/2	3/4	1	1/2	9/16	4	6
22	16	1 3/8	2 3/4	3/4	1 1/8	9/16	5/8	4	6
24	18	1 1/2	3	3/4	1 1/8	9/16	5/8	4	6
26	20	1 1/2	3 1/4	3/4	1 1/8	5/8	11/16	4	6
28	22	1 3/4	3 3/4	7/8	1 1/4	5/8	3/4	4	6
30	24	2	4	7/8	1 1/4	3/4	7/8	4	6
36	28	2	4	1	1 3/8	7/8	1	4	6

The following suggestions* concerning the safe use of emery wheels should, if observed, avert many of the accidents that frequently result in serious eye injuries:

> "Do not operate an emery wheel without protection for the eyes. Do not operate any emery wheel faster than the speed recommended by the manufacturer. Be sure that the speed is right before mounting wheel.
>
> "Be sure that the tool-rest on the emery wheel is not below the center of the wheel, and have the rest as close to the wheel as possible. An emery wheel should be running true and without vibrations. If it is not, call attention of the foreman and have the wheel fixed before operating.
>
> "Always keep bearings of grinders well supplied with oil. A hot arbor may expand and break the wheel.
>
> "Be sure that your wheel is running at normal speed before starting to grind."

One of the largest factors in the rupture or so-called explosion of emery wheels is excessive speed. Carefully prepared tables of proper speeds for each size and type of emery wheel are contained in the national code.

PROCESSES WHERE PROTECTION FROM DUST AND WIND IS REQUIRED

The hazard from exposure to dust and wind is not great except in a few occupations, such as the driving and firing of locomotive engines, commercial vehicle driving in rural districts or on dusty roads, roofing, and outdoor electric welding, where there is no exposure to radiant energy. Since this hazard, where it does exist, is so constant and evident there is little difficulty in inducing the workmen exposed to it to wear goggles. The chief consideration in the selection of goggles should be comfort. Light-weight goggles are the most desirable. Because of the danger of particles of dust entering from the side, side shields are essential. Frequently the hazard of dust and wind is combined with the hazard of glare caused by the necessity of looking at or in the direction of the sun. A locomotive engineer or motor truck driver whose train or truck is running toward the sun is subjected to this hazard. In such cases the combined hazards may be guarded against by the use of light-weight goggles with side shields and amber or other colored lenses. Workmen in the construction industries and repair or maintenance men in large industrial plants who are required to work on roofs or

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* From the handbook of Industrial Safety Standards published by the National Bureau of Casualty and Surety Underwriters, 120 West 42d St., New York City.

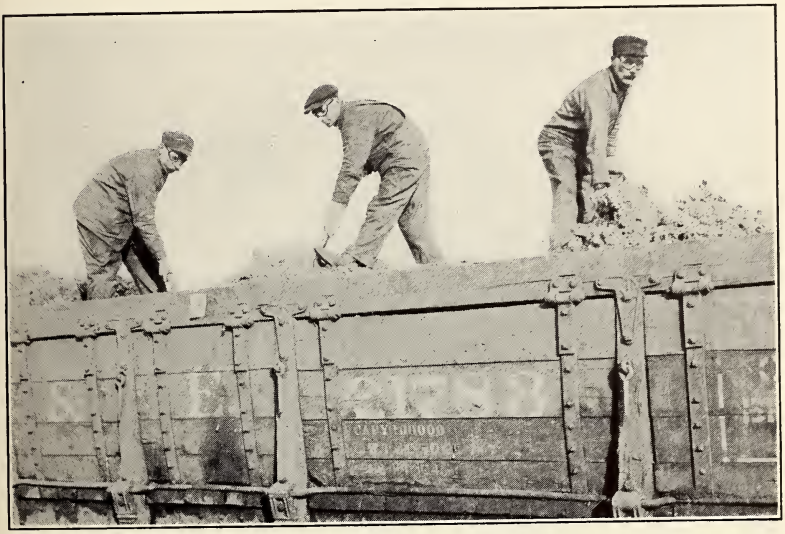

Figure 25.—Unloading ore and wearing goggles for protection against dust and glare of the sun.

in yards also are more or less constantly exposed to the hazards of dust and wind. It is recommended that such men be required to wear goggles of the type indicated above and that colored lenses be used only where there is considerable need of looking in the direction of the sun.

PROCESSES WHERE PROTECTION FROM SPLASHING METAL IS REQUIRED

The danger of injury to the eye from splashing molten metal is exceeded in severity and frequency only by the danger of injury in the chipping of steel casting, the most serious of all industrial eye hazards. This hazard is not confined to the metal producing industries, although it is of course most severe there, but confronts the employes of all other industrial concerns where babbitting, soldering or pouring of lead joints for cast iron pipes is necessary.

The nature of the operation largely determines what style of protector—goggles, face mask, helmet, shield or hood—should be used. If there is any possibility of water or moisture being present in the casting of any hot metals, the danger of the molten metal exploding is great; hence protection for the entire face as well as for the eyes is needed. In such cases it is desirable to use a substantial type of face mask such as that shown in Figure 26. Some device giving at least the degree of protection afforded by goggles should be used to protect the eyes from splashing metals in all other cases of babbitting, soldering or pouring of liquid metal. The National Head and Eye Code does not restrict the kind of material to be used for face masks or the design of such masks to be used for protection from this group of hazards. A great variety of material is available for making masks to accomplish the desired purpose and a great variety of finished masks is on the market.

Concerning the specifications for frames of goggles used in these processes, the national code points out that tests conducted by the Bureau of Standards and by the manufacturers of protective equipment demonstrate that the principal cause for the failure of goggles in these processes is the heat of the molten metal which strikes the goggles, not the impact of the explosion.

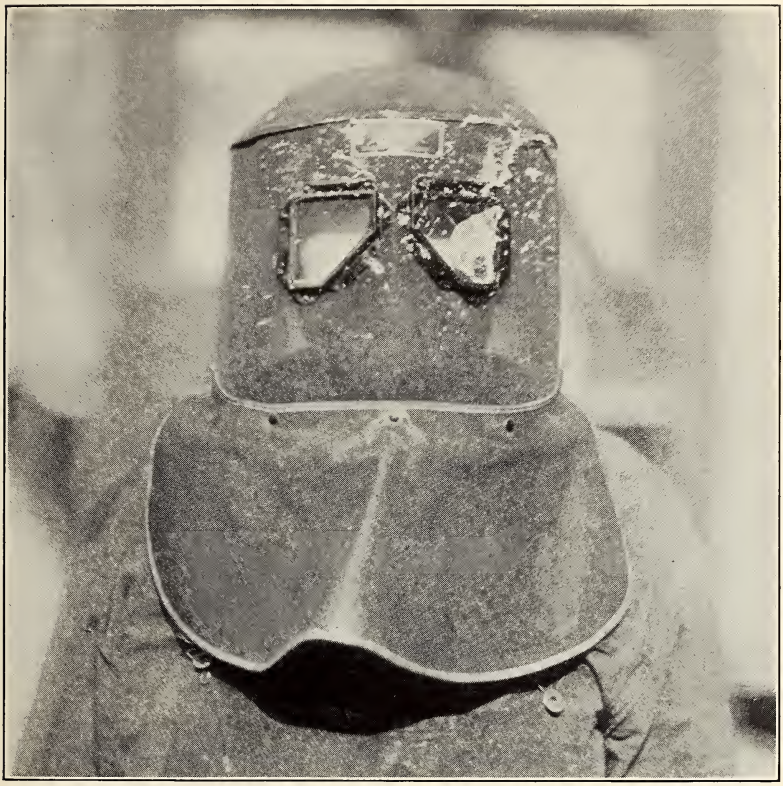

Figure 26.—One hundred percent head protection for pourers of babbitt and other molten metal where there is danger of splashing or explosion.

The test consisted of dropping molten lead from different heights on a number of lenses of different makes. It was found that in no case was the goggle frame injured, the damage being confined to cracking of the lens. With these facts in mind, it is not necessary to specify a strength test for the frames. The design of the lens container should be such, however, that in case a lens cracks the fragments will be retained in position in the container.

The molten metal drop test, which was applied to a large number of goggles, showed that in the case of the lenses also the heat of the metal and not the impact is the important element to be guarded against. It was found that for glass of a given make the thickness of the lens determines to some extent at least the resistance to cracking when molten metal is poured on the surface of the lens.

It was, therefore, concluded that protection will be afforded by a lens that will withstand a moderate blow of molten metal, and a lens container that will retain a cracked lens in position. The former is assured by placing .079 inch or 2 mm. as the minimum limit for the thickness of glass. The need of unimpaired vision in the pouring of molten metal is apparent. This is the reason for specifying 70 per cent minimum light transmission. Almost any lens made of so-called colorless glass will transmit 70 per cent of incident light.

Since the danger of burns from the explosion or splashing of molten metal, at least in the iron and steel manufacturing industries, is usually accompanied by the danger of injury to the eye from constant exposure to the intense light and heat, the goggles, masks or other protectors used in such operations are nearly always designed to afford protection against both hazards. In the iron and steel industry, most furnace men and workmen engaged in tapping, pouring and casting are exposed to all these hazards. The danger presented by radiated heat in these occupations and the means of guarding against it will be discussed later.

One of the principal difficulties in inducing men who work in close proximity to furnaces in the metal industries to wear goggles is the fact that the ordinary discomfort of goggles is greatly intensified by the retention of heat, particularly so in the case of goggles with all-metal frames. This condition may be alleviated by the use of goggles with strong fiber frames or by covering the parts of metal frames which come in contact with the face with a non-conducting material, such as rubber tubing or leather, or better still, by the use of a mask rather than goggles.

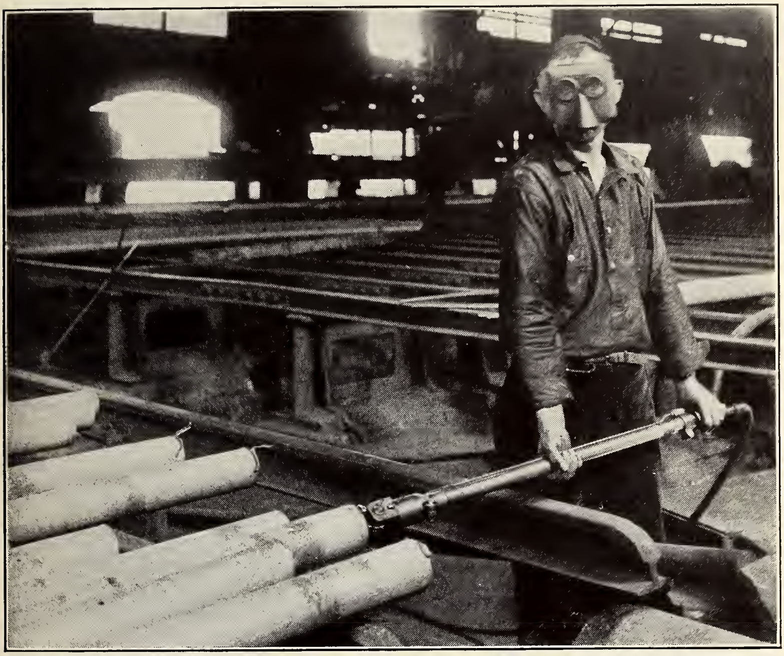

Figure 27.—A light weight mask of heat resisting material, particularly suitable for protecting the eyes of rolling mill workers who are exposed to the hazards of flying scale and the intense heat of the furnace fires.

Notwithstanding the very great and obvious hazard to the eyes from splashing metals, there are still plants where men work with molten metals without any eye protection. The excuse usually offered by such men is that the goggles "steam up," interfering with vision, and themselves become a menace because they "prevent a man seeing where to run in the case of an accident when his life may depend on a quick get-away." There is very little justification for this excuse to-day.

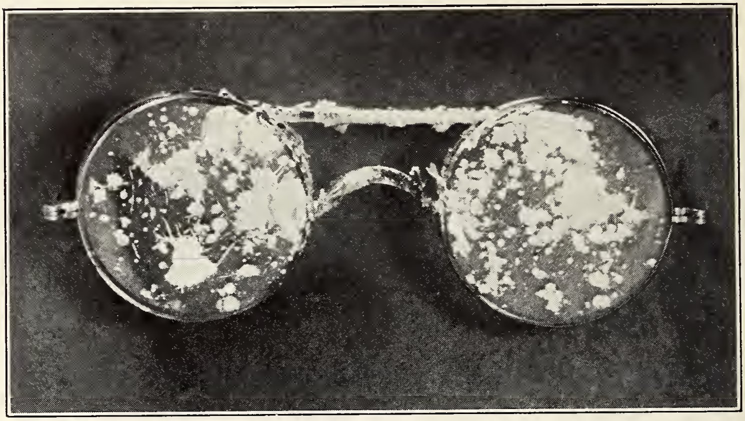

Figure 28.—One week's use in spot welding was all it took for the pair of spectacles shown above to become thus spattered with steel.

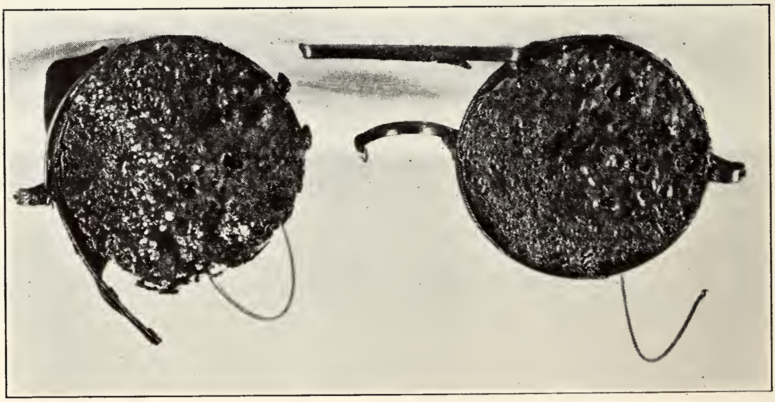

Figure 29.—An accidental splash of molten metal ruined these lenses and burnt the workman's face, but the goggles saved his eyes.

Modern goggles are so designed and constructed as to minimize the clouding of lenses. Practically all types of goggles for foundry work, both those with metal frames and those with fiber frames, are now constructed with rows of small holes or slits on the side shields which insure a current of air close to the lenses. Even in plants where less modern types of goggles are in use the clouding or steaming up of goggle lenses can be prevented by the use of a glycerine pencil or—as it is more commonly called in the shops, sweat pencil—to paint a thin film over the lens. Some industrial men report similar good results through the use of a clear white soap. A sweat band improvised from some absorbent textile material and used on the forehead to absorb moisture and prevent perspiration from running into the eyes of workmen also helps to relieve this difficulty. The Dominion Forge and Stamping Company has found such a device so effective in preventing the clouding of goggles that it provides its workmen with a neat and substantial cheese-cloth band. This band, which is shown in Figure 30, can be made up in any plant at the cost of five or ten cents.

The old school of industrial workers and foremen and some plant executives are traditionally opposed to refinements in the methods of preventing accidents. The introduction of such things as clean cheese-cloth sweat bands is likely to be rejected by workmen of the old school as "sissy stuff." On top of this, many employers and supervisors are frequently discouraged by the difficulty of getting foundry men to wear any sort of protective equipment. The severity of accidents which occur in the pouring of molten metal is sufficient justification for resorting to every possible means of guarding against injury to the eyes in this work.

The babbitting mask shown in Figure 26 and the goggles in Figures 28 and 29 are vivid illustrations of the seriousness of this hazard. In each of these instances the wearer was undoubtedly saved from total blindness.

While eye protection in the foundry is nearly always thought of, first of all, in terms of goggles and masks, there is great opportunity for reduction of accidents through general plant improvements, such as proper lighting and ventilation, and through the revision of methods of operation. For instance, serious accidents may occur from the spattering of molten metal in filling and in emptying a ladle. To avoid this when filling from a continuous stream of metal, the stream should be cut into from the front, instead of from its back. Ladle lips should be so designed that a smooth flow in a concentrated stream is also secured.

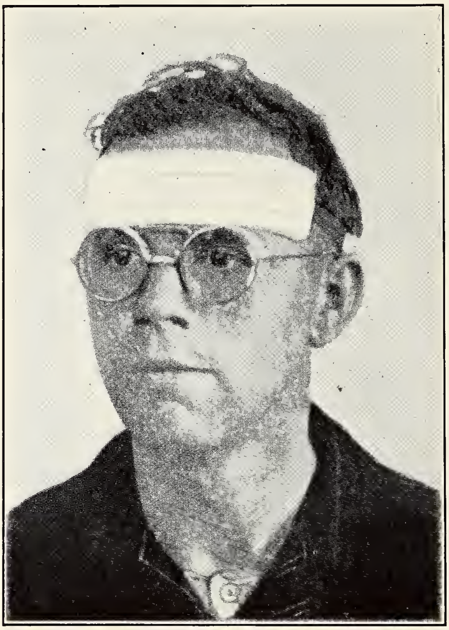

Figure 30.—A cheesecloth sweatband to keep perspiration out of the eyes of workmen wearing goggles.

Explosions are caused by the molten metal coming in contact with moisture in a ladle. Thorough drying of ladles will prevent such an occurrence. Large ladles are frequently dried in core ovens. This prevents fouling of the foundry air by smoke which would result if the drying were accomplished by having fires built in the ladles, as is still done in some foundries, or by attempting to dry large ladles on a heater intended only for the single-hand ladles.

When the lining and drying of ladles are under control of one man, a better opportunity is afforded to inspect all ladles thoroughly every day. Inspection for cracked or thin bowls, loose rivets, eroded shanks, defective welds, imperfect balancing, as well as daily attention to safeguarding the gear mechanism, is thus concentrated under one man's watchful eye. Moreover, the foreman himself can give better supervision to this work when one man is delegated to the task. This method also tends to insure storage of ladles, in a dry place instead of in damp corners or on wet sand, where they are apt to rust. Large ladles which remain unused for long periods should be stored on supports to provide air space and to prevent absorption of moisture from the ground.

Not only must dampness or moisture be avoided in the ladle, but likewise in the crucibles and in the molds. When exposed to high temperatures, if the crucible contains moisture, there is rapid evaporation of the moisture into steam, which causes explosions. The storing of crucibles in dry, heated places before using, and when not in service, and the avoidance of their exposure to dampness in the fuel used in storage oven or melting furnace, will maintain them in safe condition.

Turn-over pig molds when not in use should be left upside down to prevent their accumulating moisture.

PROCESSES WHERE PROTECTION FROM GASES, FUMES AND LIQUIDS IS REQUIRED

The operations in which protection must be provided against this group of hazards are principally the handling of corrosive chemicals, acids and caustics, dipping as in galvanizing operations, brush coating as in some japanning operations, the repairing of pipe lines and of other acid conveying apparatus, and any industrial use of wood alcohol. The danger of injury to the eye from this group of hazards is most serious in such industries as the manufacture of storage batteries, soap manufacturing, aniline dye manufacturing, and in such processes in other industries as call for acid baths, bright dips, and metal plating because in these industries and operations there is almost continuous use of acids and other dangerous chemicals.

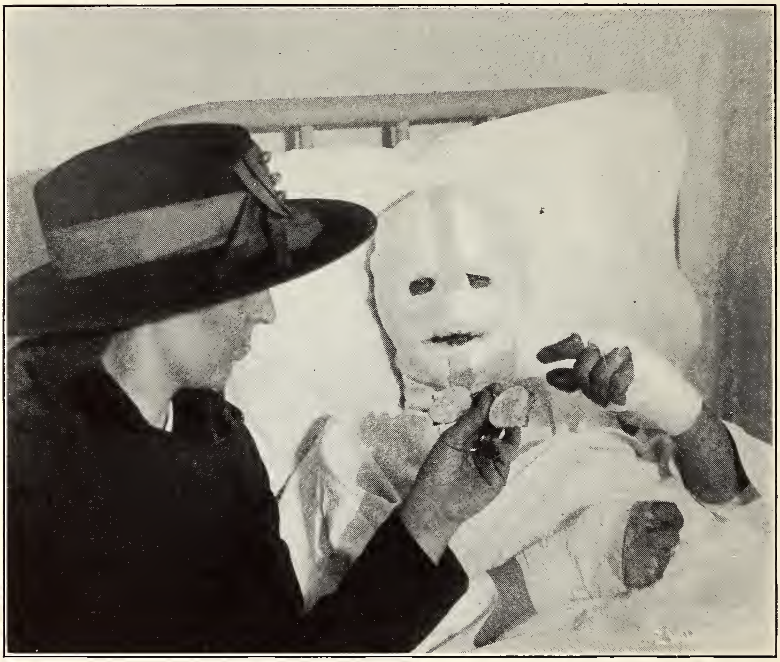

Figure 31.—Splashing cyanide burned this man's hands and face severely, but goggles saved his eyes.

While the danger of burns of the eye from sulphuric acid in the manufacture of electric storage batteries is generally recognized and guarded against in that industry itself, this hazard is not so well known, nor is it to any extent guarded against among mechanics working on storage batteries on automobiles in garages. Three cases of serious burns of the eyes among automobile mechanics are reported in a paper by Dr. Harry Gradle.*

As a help to understanding how these accidents occur, a brief description of storage batteries is given. The battery consists of an acid-proof cell containing lead plates pasted with lead oxides and filled with dilute sulphuric acid. There are several vents in the acid-proof cover, two closed by the usual electrode connections, while the others, which are for ventilation, are usually closed by rubber screwcaps with a pinhole aperture. Such a battery is continually charging or discharging unless it is completely inert. During the process of charging, heat and hydrogen are generated. When the battery is at an electrically low ebb, the heat and hydrogen given off are very small, while a fully charged battery has a temperature as high as 284° F. The hydrogen at this point shows as bubbles in the battery solution, and an open flame of any sort—an electric spark, a blow-torch, or a cigarette—will ignite the hydrogen which has been mixed with air and will burn with an almost instantaneous flame. There would be no danger if these gases were unconfined, but as the flame occurs within the small air chamber in the cell it causes an explosion and the burning gases and sulphuric acid which lie near the surface are driven through the ventilation aperture.

The force with which the mixture is expelled from the cell depends upon the hydrogen present, but the hot sulphuric acid may be driven several feet into the air. If the space between the cell cover and the surface of the acid is such as to leave a large dead space for the accumulation of hydrogen, the force of the explosion will blow the cell cover off, spattering the acid in all directions.

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*Journal of the American Medical Association, November 25, 1922.

In two of the cases cited by Dr. Gradle the explosion was caused by a blow-torch and in the third by a spark from a live wire which was short-circuited. In one case the hot acid was splashed into both eyes and in the other case into one eye, resulting in severe burns particularly affecting the cornea and resulting in corneal opacity. It was thought that this condition was caused by the flame and the heat and not by the action of the chemical. This opacity, it is stated, has a tendency to increase in amount and impenetrability until the cornea has lost its major attribute of complete transparency.

While there does not seem to be any immediate therapy that will lessen the severity of corneal involvement of such a burn, the prevention of battery burns of the cornea is simple. A protective goggle, it is stated, should be worn by every mechanic who works with charging batteries. It need not be so large that it interferes with work or so close fitting that it prevents evaporation of the perspiration from the underlying skin, but it should be large enough so that a splash of acid would be prevented from reaching the eye. In every shop where such explosions are a possibility a large bottle of a sterile saturated solution of sodium bicarbonate and an eye-cup should be provided, and if such an accident should occur, the eye should be flushed thoroughly and repeatedly with the solution. The eye should then be filled with sterile borated petrolatum and the injured person sent to the nearest physician.

The nature of the process for which protection is furnished when handling acids, caustics, fumes, and other corrosive or poisonous chemicals, determines to a great extent the type of protector to use. The operations are so varied that it is not deemed advisable, even in the Head and Eye Safety Code, to prescribe in detail the type of protector to be used. Judgment and experience must determine this.

Goggles which do not fit the configuration of the face should not be used. To avoid splashing liquids coming in contact with the eyes it is desirable to use goggles with eye-cups which fit closely, but which are provided with ventilating openings covered in such manner as to prevent the entrance of liquid into the eye. This will afford a means for the escape of vapor arising from perspiration which would otherwise condense on the lenses and obscure vision. Even the provision of ventilating openings will not obviate this altogether. In those cases where the presence of fumes would undesirably affect the tissues or would irritate the eyes or nostrils, ventilation should not be provided.

In processes where the operator is exposed to splashing or projection of large amounts of acids or caustics into his face, it is desirable to protect the entire face or even the entire head. A variety of material is available for making masks and hoods to accomplish the purpose, the design being such that there are no openings in the mask through which chemicals might pass.

Protectors for these processes are not likely to be subjected to severe mechanical shocks, and for this reason no strength tests are necessary. The material of which the lens is made should be given consideration before the protector is put into use. For example, the chemicals used in the frosting of glass (such as lamp bulbs) undesirably affect the glass, and hence in handling such substances other material must be used for the lens. Cellulose acetate is widely employed. A property of this compound which makes its use desirable is its slow-burning quality. In this respect it is much more satisfactory than cellulose nitrate or celluloid.

Perhaps the most concise statements of what constitutes safety in the handling of caustic soda and in the handling of acid carboys are those contained in data sheets Nos. 2 and 3 prepared by the Chemical Section of the National Safety Council; these are reproduced in full.

SAFETY IN HANDLING CAUSTIC SODA

Hazards

1. Dripping and Splashing.
2. Vapors.
3. Flying Particles and Dust.
4. Improper Wearing Apparel.

Causes

1. Dripping and Splashing:
    a. Leaking pipe lines, pumps, tanks.
    b. Disconnecting pipe lines or other equipment in making repairs.
    c. Overflowing tanks.
    d. Splashing when liquor enters tanks, pots and drums.
    e. Handling filled drums before solidification.
    f. Releasing air from a caustic blow case.
2. Vapors:
    a. Boiling liquor.
3. Flying Particles and Dust:
    a. Breaking solidified caustic for samples, etc.
    b. Sweeping and washing floors, etc.
    c. Liquid caustic collecting on apparatus, solidifying and dropping off.
    d. Grinding and flaking solid caustic.
4. Improper Wearing Apparel:
    a. Wrong methods of dressing.
    b. Lack of proper body protective devices.

Safety Measures

1. Dripping and Splashing:
    a. Pipe lines should be made up with companion-flanged joints (not flanged unions) and with gaskets of caustic-resisting material fitting inside of bolt circles. Flanges should be screwed on clean threads without

use of joint compound. For high-pressure lines, extra heavy pipe and flanges should be used with pipe ends peaned inside of flanges.

Pipe lines require washing out occasionally to remove crystallized salt and caustic which accumulate and are liable to cause excessive pressure if formed in sufficient quantities.

Caustic pumps should be of vertical submerged type wherever possible to avoid use of stuffing boxes.

Apparatus such as evaporators, used in handling liquor caustic under pressure, should be tested periodically with cold water and under a somewhat greater pressure than that to which it is ordinarily subjected in order to detect leaks.

b. In disconnecting pipe lines or other equipment, workmen should operate from above their work whenever it is possible, should be sure that there is no pressure on the line, and that the line has been thoroughly drained before breaking flanges. The valve which controls the line should be closed and a danger sign hung upon it until the repairs are completed. Repair men working on caustic lines or equipment should be provided with a pail of clean water, near at hand, for instant use if needed.

c. Tanks must necessarily be provided with large overflow openings near the top. Such openings should be guarded with baffle plates installed in such a manner as to prevent floating material on the surface of the liquor from obstructing them.

Open-top tanks should also be provided with troughs attached to the outside, near the top, and in such a manner that in case a tank overflows, the liquid will be conveyed to an opening away from passageways and locations where workmen are liable to be.

d. Containers into which hot caustic is to be run should be absolutely dry, in order to guard against explosions. Extreme caution on the part of workmen must be exercised to prevent injury from splashing when liquor is entering drums or other containers.

e. Filled drums, handles on trucks, should be covered to prevent danger from splashing. Flat trucks operated by hand, should be provided with long handles, or with long push-poles in case of trucks without handles. Where tracks are not provided, the roadways should be smooth as possible.

f. Where blow cases are used for handling caustic solution, proper care should be given the equipment and periodic inspection made of the blow cases, pipe lines, air lines, etc. The air release line for venting a blow case should point neither upward nor horizontally, but should point straight down with the end of the line close to the ground. Or it is even better to discharge the release line into a small pit connected with the sewer system.

2. Vapors:

a. Pots, etc., containing boiling liquor, should be provided with hoods to carry off the vapors.

3. Flying Particles and Dust:

a. In breaking up solidified caustic by hand, it should always be contained in, or covered with a soft material (such as burlap), to prevent pieces from flying.

b. Floors, etc., should be washed rather than swept, in order to avoid flying dust, and washing should always be done with a hose stream. All cleaning should be done at a time when the least possible number of persons are working in a building.

c. Liquid caustic will collect on apparatus from vapors, from splashing and from leaks and will solidify and drop off. Apparatus should be kept as clean as possible by frequent washing and by scraping when necessary.

d. Grinding and flaking of solid caustic should take place in a special room for the purpose, remote from other operations, and the least possible number of men should be employed at the process. These men should be equipped with air hoods covering the entire head and neck. Floors, walls, and apparatus should be washed off with a hose after each day's grinding. Hot water is preferable to cold for removing solidified caustic.

4. Improper Wearing Apparel:
   a. Cotton clothing, which will withstand the action of caustic much better than wool, should be used entirely. Wide-brimmed hats will tend to protect the head and neck. Rubber boots or shoes with an extra sole of combined rubber and cotton (such as rubber belting) attached, will be found very effective. Trousers should always be worn outside of boots or shoes. Shirts should have long sleeves and should fasten tightly about the neck. Cotton mitts with a moleskin facing should be worn by all caustic workers, except those required actually to handle or touch the caustic. These should wear heavy rubber gloves.
   b. The most important feature in the protection of workmen against caustic burns is that of guarding against injury to the eyes. Caustic on other parts of the body can usually be neutralized quickly and without serious results, but eye burns are extremely dangerous, often resulting in loss or impairment to vision, and in case of hot caustic burns, are almost certain to result seriously. Proper goggles should be worn by caustic workers at all times wherever it is possible, and where it is not possible, nothing less than ordinary eye glasses should be used.

SAFETY IN USE OF ACID CARBOYS

Causes of Accidents

1. Breaking of Carboys:
    - a. By failure of jackets.
    - b. By rough and inefficient handling.
    - c. By pressure in carboy.
    - d. By improper packing or lost resiliency of packing by reason of wetting.
2. Spilling Contents:
    - a. While filling and emptying.
    - b. While handling.
3. Using Carboys for Other Purposes:

Preventive Measures

1. Breaking of Carboys:
    - a. Failure of jackets.

Store carboys on 2 x 4's to keep the bottoms dry and prevent them from rotting. This will also keep the boxes from coming in contact with any corrosive materials spilled on floor.

Never attempt to lift or move a carboy without first examining the jacket to see that it is not broken or weakened by the action of spilled acid. There should be some conspicuous method of marking defective jackets or carboys and whenever one is discovered in bad condition it should be marked at once in order to protect persons who might not notice the defect.

Painting jackets outside and inside with acid-resisting paint adds considerably to their life and prevents acid from reaching the nails in the box. Some works paint their carboys distinctive colors for each acid.

Do not store carboys in the open—protect them from the weather.

Never use a jacket which is broken or weakened in any way. It is cheaper and safer to replace it with a new one.

If carboys are to be moved by elevator or other mechanical means use care to see that they will not fall or be struck by some object.

b. Rough, inefficient handling.

Use a good type of carriers for moving carboys. They not only prevent breakage and enable the workmen to keep out of range of slight splashes but are real efficiency devices as well.

Avoid shocks to carboys such as bumping against objects or dropping on floor. The containers are glass and even though they are packed and padded in the boxes they are easily broken. Carefully remove the protecting hood to avoid jarring the stopper loose and breaking the neck of the carboy. Never strike the hood sideways.

Avoid undue shaking.

Where small carboys, jugs or bottles of acid are being carried around the plant, wooden boxes or other carrying devices with handles should be provided and where more than one bottle is being carried in the same carrier they should be separated.

Pile carboys carefully and not over two high. The I. C. C. rules on shipments of carboys give valuable data on piling, storing and handling carboys.

c. Pressure in carboys.

The bottles after filling are hermetically sealed. Unless a 10 per cent air space is left in the bottle to allow for expansion, pressure generated by the expansion of contents due to changes in temperature or reaction will break the bottle or cause acid to spurt out when stopper is removed. To prevent unnecessary expansion never place carboys near a radiator or in the sun.

If carboys are to be stored for any length of time a good plan is to remove the stopper, cut out a small section of the gasket for a vent and then replace the stopper. This is to allow any gases or undue pressure to escape.

2. Spilling of Contents:
   a. While filling and emptying.

Loosen stoppers carefully lest there be pressure in the container which would cause the acid to spurt out.

Pour slowly and drain thoroughly. Replace and fasten stoppers after emptying. A good type of carboy inclinator facilitates and simplifies the emptying, especially where small quantities are poured out at a time.

The use of compressed air or siphons for emptying carboys is bad practice as it leaves a small amount of dangerous acid in a carboy supposed to be empty. Compressed air is apt to break carboy and spatter contents.

   b. While handling.

Always see that stoppers are in place and securely fastened before moving. If the stopper has been once removed, replace it and use a lead alloy cover. In removing carboy from pile never tip the top of the carboy toward yourself or another man.

Wash out empty carboys by turning them upside down over an inverted stream of water, but remember to take the same precautions with empty carboys as with full ones. They often contain a small amount of acid.

Always keep the bottle in an upright position—do not tip it or carry it on its side.

Wear rubber aprons, rubber boots with trousers outside of boots—not tucked into them, rubber gloves, *face mask or goggles at all times while working around carboys.*

Always have a supply of water readily available to wash off any acid spilled on the body.

Provide either a shower or a tub of lime water large enough to step into or sit down in if necessary. A wide mouth bottle or eye cup is also desirable.

3. Using Carboys for Other Purposes:

Do not use carboys for drinking water or for other purposes than to hold acid.

The most serious accidents in the handling of acids often occur in plants where only small quantities of acid are used. For instance, a company may have need for not more than a single carboy of acid during an entire year. This company, as is frequently the case, may be engaged in work that is not at all hazardous, or its principal accident hazards may be so far removed from the handling of acids and other dangerous chemicals that the prevention of accidents from this source may not even be considered in its safety program. In such a plant little attention is paid to the carboy of acid and it is put away in some dark corner where it will be out of the way until needed. Sooner or later some of the acid is required; a workman is sent to fill a pail, and in the attempt to pour the acid out of an unwieldy carboy a slip occurs. Or there is some other unexpected spilling and splashing of the acid, with the usual result: a badly burned workman, perhaps blinded for life, and $1,500 to $6,000 to be paid as compensation for loss of sight.

Accidents of this kind are to be expected unless the acid container is securely fastened to an inclinator, a device which should always be provided even when but a single carboy of acid is carried in stock. Quite a variety of carboy inclinators which can be handled safely even by one workman are now on the market. Several types of inclinators may be easily constructed in the carpenter shop or blacksmith shop of any industrial plant. Figures 32 and 33 show inexpensive and safe carboy inclinators.

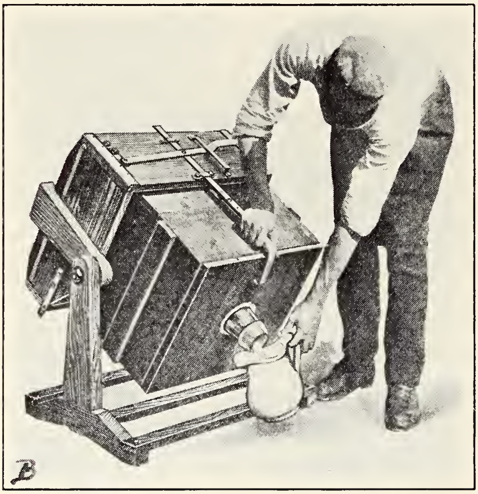

Figure 32.—Pouring acid safely with the receptacle close to the mouth of the carboy so as to avoid splashing.

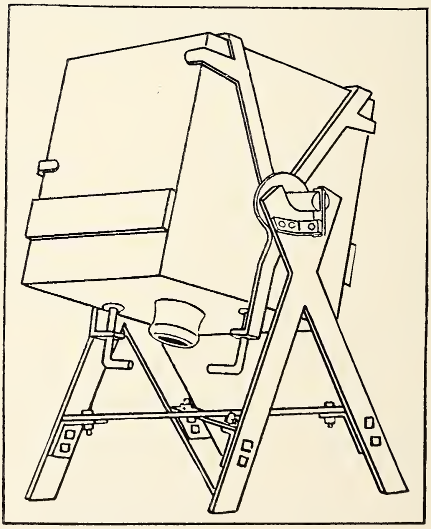

Figure 33.—A carboy handling device which reduces the possibility of splashing in the pouring of acids and other injurious chemicals.

The transportation of acid containers also presents a serious accident problem, but one which is easily solved by provision of a suitable type of carrier. The old practice of carrying carboy containers by passing two sticks under the side cleats is a dangerous, expensive and inefficient method. The General Chemical Company has designed and put into use a two wheel carboy carrying device, shown in Figure 34, which can be easily and safely operated by one man. This device is a variation of the common two wheel hand truck. To pick up the carboy box, the carrier is simply pushed forward, the cleats going under the side pieces on the box. The cleats are readily adjustable for carboy boxes of any width. The moving and pouring of acids should, whenever possible, be made the work of one set of men who should be acquainted with the special hazards incidental to such work, trained in the methods of preventing accidents and frequently reminded of the dangers and of their responsibility for guarding against them.

Danger to Eyes from Industrial Poisons

The continued introduction, during recent years, of industrial processes making use of new poisonous substances has created a number of serious health hazards involving various forms of injury to the eye and its accessory nerves. The enormous increase in the production of dye stuffs and other chemicals in the United States since the World War adds considerably to these hazards. A comprehensive list of occupational health hazards, their diagnostic signs, the physical impairments to be looked for, and an enumeration of the occupations in which workmen are exposed to the various poisonous hazards are contained in Bulletin 306 of the Bureau of Labor Statistics, United States Department of Labor, issued in April, 1922. Fifty-two different poisons used in industrial processes are cited in this list, and in at least half of these cases more or less serious injury to the eyes, results from continuous handling of the poisons or continuous work in close proximity to them.

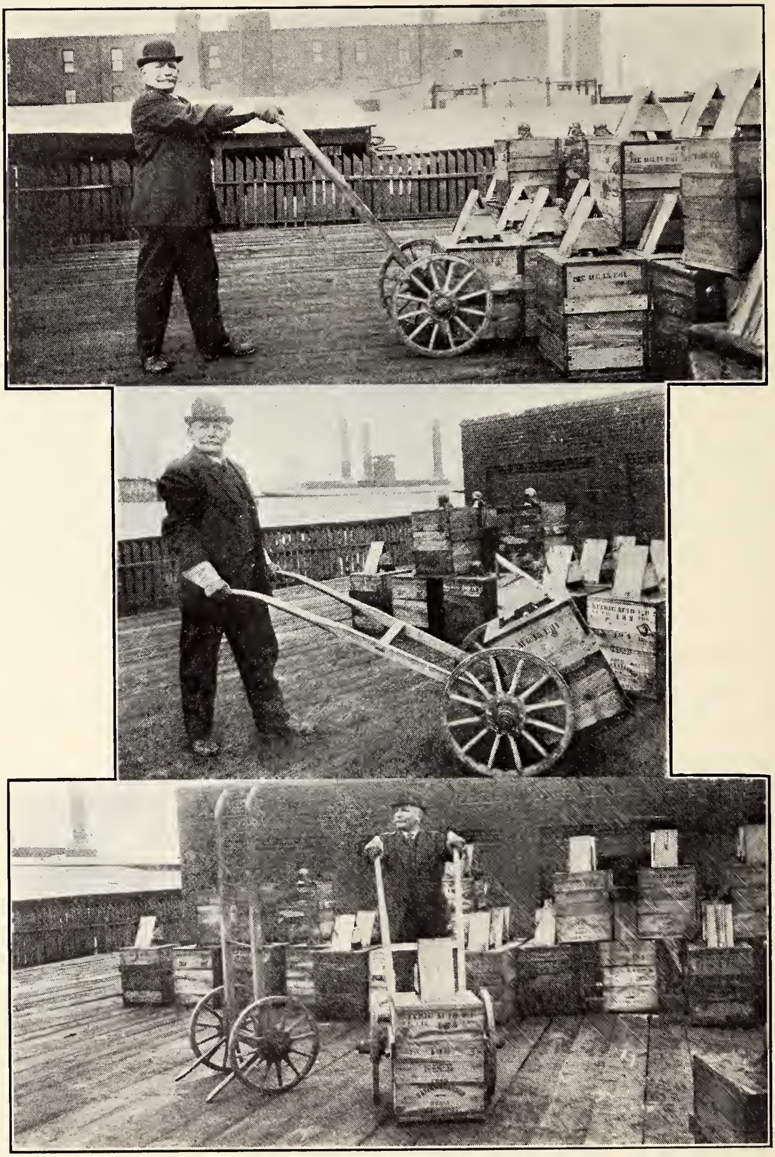

Figure 34.—A handy and safe two-wheel carboy carrier with cleats adjustable for the side pieces of carboy boxes of any width.

A list of the poisons which affect the eyes, the symptoms to watch for among employes using these poisons, and the occupations in which workers are exposed to these hazards will be found in Appendix I of this volume.

The most common results are irritation of the mucous membranes, causing lachrymation or excessive watering of the eyes and light flashes before the eyes. Other results may be the discoloration of the conjunctiva, disturbance of the sense of vision, retrobulbar neuritis, choroiditis, dilatation of pupils, photophobia, clouding of the cornea, diplopia from paralysis of the muscles of the eyes, amblyopia, protrusion of the eyes, contraction of pupils, ulceration of orbital bones, shrinking of the eyeballs, erosion of the cornea, transient blindness, progressive atrophy of the optic nerve, and permanent blindness.

The mode of entrance of these poisons into the body is most frequently in the form of vapor, through the respiratory organs. The inhalation of dust may produce equally harmful effects. Direct action of the poison through or on the skin is another method of entry, and occasionally the poison is carried into the body through the handling of food-stuffs, cigars, cigarettes, chewing tobacco, etc., with hands from which the toxic substance has not been thoroughly cleansed.

Of special note as productive of serious results are ammonia, benzol, and the other intermediates of the dye industry, brass, carbon disulphide, dimethyl sulphate, hydrofluoric acid, lead, methyl alcohol, methyl bromide, nitroglycerin, and phosphorus. It should be noted also how wide-spread is the danger of poisoning from lead and its compounds which results among other things in atrophy of the optic nerve. More than a hundred different occupations offer exposure to this one hazard.

Lead and Its Compounds

The symptoms of lead poisoning are: Sallow, pale, yellowish hue of the skin; metallic taste; nausea; anorexia; constipation; lead line; asthenia; lassitude; headaches; arthralgias and neuritis; weakness of grip; tremors of fingers and tongue; lead paralyses, especially of muscles used most; *atrophy of optic nerve.*

Those exposed to this hazard are: Acid finishers (glass); amber workers; art-glass workers; artificial-flower makers; babbitters; battery (dry) makers; bench molders (foundry); blacksmiths; blooders (tannery); bookbinders; bottle-cap makers; brass founders; brass polishers; braziers; brick burners; brickmakers; bronzers; browners (gun barrels); brush makers; buffers (rubber); burners (enameling); cable makers; cable splicers; calico printers; canners; cartridge makers; celluloid makers; chargers (zinc smelting); color makers; colorers (white) of shoes; compositors; concentrating mill workers (lead and zinc); cut-glassworkers;

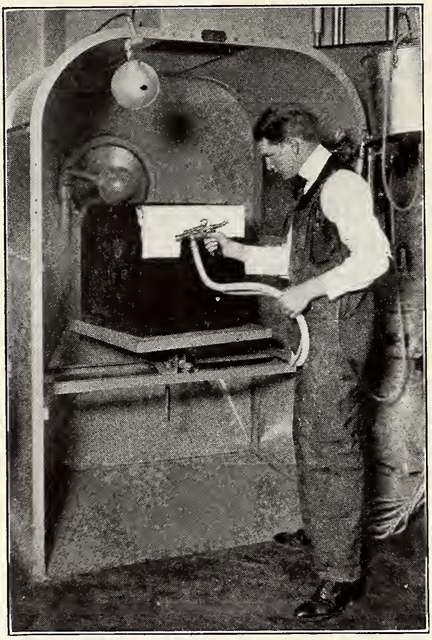

Figure 35.—Applying a finish by the spray process, showing hood and exhaust for removal of noxious fumes.

Courtesy American Museum of Safety.

cutlery makers; decorators (pottery); diamond polishers; dye makers; dyers; electroplaters; electrotypers; embroidery workers; emery-wheel makers; enamel makers; file cutters; filers; floor molders (foundry); galvanizers; glass finishers; glass mixers; glass polishers; glaze dippers (pottery); glaze mixers (pottery); glost-kiln workers; gold refiners; grinders (metals); grinders (rubber); heater boys (riveters); imitation-pearl makers; incandescent-lamp makers; insecticide makers; japan makers; jewelers; junk-metal refiners; labelers (paint cans); lacquer makers; lead burners; lead-foil makers; lead miners; lead-pipe makers; lead-salts makers; lead smelters; linoleum makers; linotypers; linseed-oil boilers; lithographers; lithotransfer workers; match-factory workers; mirror silverers; mixers (rubber); monotypers; musical-instrument makers; nitric-acid workers; nitroglycerin makers; painters; paint makers; paint removers; paperhangers; patent-leather makers; petroleum refiners; photograph retouchers; pipe fitters; plumbers; polishers; pottery workers; printers; putty makers; putty polishers (glass); reclaimers (rubber); red-lead workers; refiners (metals); riveters; roofers; rubber workers; sagger makers; sandpaperers (enameling and painting auto bodies, etc.); screen workers (lead and zinc smelting); sheet-metal workers; shellac makers; shot makers; slip makers (pottery); slushers (porcelain enameling); solderers; stainers (shoes); steel engravers; stereotypers; storage-battery makers; sulphuric-acid workers; table turners (enameling); tannery workers; temperers; tile makers; tin-foil makers; tinners; toy makers; transfer workers (pottery); tree sprayers; typefounders; typesetters; wallpaper printers; welders; white-lead workers; wood stainers; zinc smelters.

Methyl Alcohol (Wood Alcohol)

Perhaps the most serious of all the hazards from industrial poisons is that involved in the use of methyl alcohol or wood alcohol, as it is more commonly known. The seriousness of this hazard lies both in the wide-spread use of this poison in industry and in the fact that its effect on the retina and optic nerve often results in total blindness.

A list of the industrial workmen who are usually exposed to the hazard of wood alcohol poisoning follows:

Aldehyde pumpmen; art-glass workers; artificial flower makers; artificial silk makers; bookbinders; bronzers; brush makers; calico printers; celluloid makers; cementers (rubber shoes); dimethylsulphate makers; dry cleaners; dryers (felt hats); dye makers; explosives workers; feather workers; felt hat makers; filament makers (incandescent lamps); fitters (shoes); furniture polishers; gilders; hardeners (felt hats); incandescent lamp makers; ink makers; japan makers; lacquer makers; lasters (shoes); linoleum makers; millinery workers; mottlers (leather); painters; paint makers; patent-leather makers; perfume makers; photoengravers; photographers; polishers; shellac makers; shoe-factory operatives; shoe finishers; soap makers; stiffeners (felt hats); stitchers (shoes); type cleaners; upholsterers; varnish makers; vulcanizers; wood-alcohol distillers; woodworkers.

There are numerous other industrial occupations—including some clerical occupations, such as the cleaning of mimeograph machines and other office equipment—in which this hazard exists, though the exposure is not so continuous or severe as in the foregoing list. Wherever an individual is required to use wood alcohol, even if only on rare occasions, its danger should be understood.

The danger of total blindness or death from the drinking of wood alcohol has become common knowledge in recent years, but comparatively few people appreciate the harmful physiologic action which may follow the absorption of wood alcohol through the mucous membranes of the body. One investigator reports more than one thousand casualties from the use of this poison.* It must be said, however, that there are some persons who are almost wholly immune from any toxic effect from wood alcohol.

Wood alcohol, or any fluid containing wood alcohol, should be labeled on its container as a poison, with the warning plainly displayed to the effect that, taken internally, it may cause blindness or death. The usual poison designation, the skull and cross-bones, should appear prominently. Inclusion

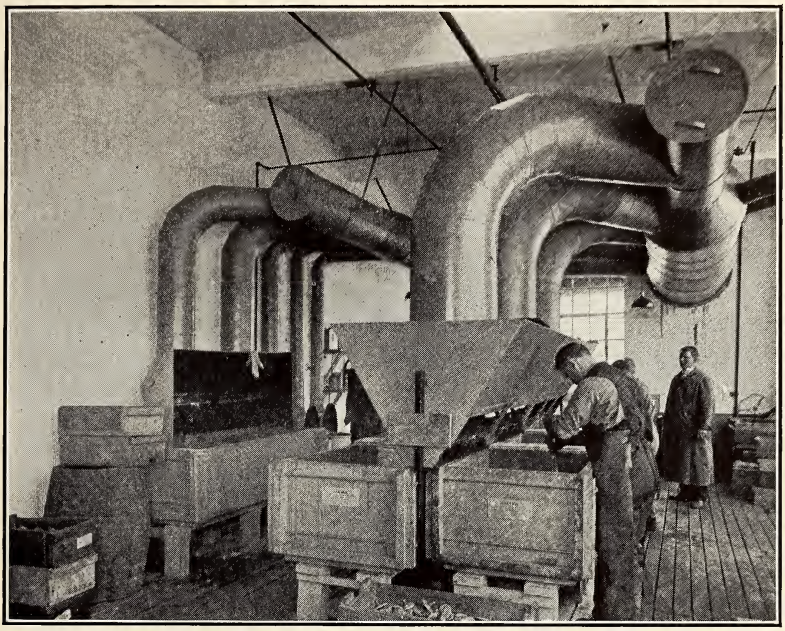

Figure 36.—Exhaust system for removing acid fumes. The suction opening is below the operator's breathing line, and no fumes reach his face.

Courtesy American Museum of Safety.

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* "Wood Alcohol. A Report on the Chemistry, Technology and Pharmacology of and the Legislation Pertaining to Methyl Alcohol," Charles Baskerville, Ph.D., F.C.S.

of a further warning that the fumes of wood alcohol inhaled in an insufficiently ventilated place are likewise injurious to eyesight is an advisable precautionary measure.

In order to protect workers who might be exposed to its fumes, exhaust systems should obtain wherever needed, and ventilation by artificial means where necessary should be provided in such operations as the varnishing of inclosed vats where the workers are particularly exposed to the poisonous fumes, in the varnish rooms of furniture factories and in all other workrooms where these fumes may be constant.

Where workmen are forced to dip their hands and arms into substances of which wood alcohol is an ingredient, they should be provided with arm coverings impervious to the effect of the liquid.

In certain processes in which wood alcohol is employed it becomes a constituent part of the final product and is not thereafter a hazard. In all processes in which it remains as wood alcohol, the dangers attendant upon its use should be most carefully guarded against.

PROCESSES WHERE PROTECTION FROM AN EXCESSIVE AMOUNT OF DUST AND SMALL FLYING PARTICLES IS REQUIRED

This hazard exists principally in sand blasting operations. There have been developed and are now in use, in progressive plants, sand blast cabinets so arranged that the operator directs the nozzle of the sand blast hose on the material which is to be cleaned through small dustproof openings in the wall of the cabinets, watching the progress of the work through a glass shield. Such cabinets provide complete protection for the eyes of the operator. Where the worker is actually exposed to the sand, shot, or other abrasive used in such operations nothing less than a hood which completely covers the head and which fits snugly around the neck is suitable.

The hood must be so designed that the operator is able to see his work without straining the eyes. Two types of windows for sand blast hoods are in general use. One type of hood has a glass window supplemented by a metal screen on the outer side to protect the glass from pitting. In another type of hood, wire screen without the glass is used. To obtain complete protection for the eyes, goggles should be used with the latter type of hood.

Sand blast operations are required for the cleaning of metal castings and stone surfaces of buildings, for the removal of paint from railway cars and for numerous other industrial occupations. This operation again presents frequent opportunity for the elimination of accident and health hazards through engineering revision rather than by the use of hoods, goggles or respirators. The substitution of tumbling mills for the old method of hand scrubbing of castings is a good example of the elimination of this hazard through engineering revision. Many castings, however, are too large to be put into tumbling mills and the fragility and fine surfaces of others make the use of sand blasting necessary.

Sand blasters sometimes attempt to use home-made helmets or other protective equipment of their own design. This is in most cases a dangerous practice and should not be permitted except where the device has been carefully examined and approved by a competent safety engineer.

In certain sand blasting work it is necessary to provide for ventilation of the operator's hood; in some types of hoods provision is made for the use of air under pressure. This has not worked out entirely satisfactorily. Frequent complaint is made of colds in the head. The design of hoods to secure proper distribution of air and proper air pressure should be the subject of further consideration by employers whose workmen require such hoods and by the manufacturers of protective equipment.

OPERATIONS WHERE PROTECTION FROM REFLECTED LIGHT OR GLARE IS REQUIRED

The hazard from reflected light or glare in indoor illumination is covered thoroughly in a subsequent chapter. We are dealing here only with outdoor reflected light or glare outdoors and with one indoor operation, die-making, in which there is a similar hazard.

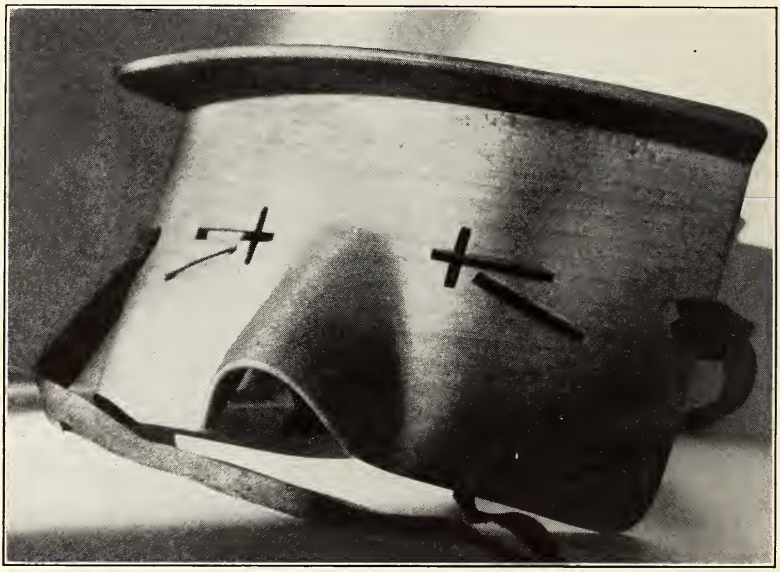

Figure 37.—A wooden model of a walrus hide eye protector used by Eskimos as far back as two hundred years ago to protect their eyes against snow blindness.

This hazard and means of overcoming it antedate American industry. Eskimos have always been confronted with the problem of snow blindness, which is nothing more than the hazard of reflected light, and they early developed an ingenious form of protection—half goggle and half mask—

illustrated in Figure 37.* Thousands of American workmen, such as locomotive engineers, inter-city commercial vehicle drivers, railroad track men, yard men, structural steel workers, repair men, electric line men and other outdoor workmen, are exposed to an identical hazard during the winter months, and even a greater number of men in similar occupations are exposed to the hazard of glare from the sun's rays during the summer months.

The style of goggle to be used for protection against sunlight reflected from snow and similar sources of glare is of no particular moment. The reduction of the intensity of radiation entering the eye is the end to be accomplished. Since this can be done by the provision of a large lens, the use of side shields should be left to the discretion of the wearer, as should also the density and tint of the colored glass used in the lenses.

Metal die-makers are very often subjected to the hazard of reflected light from the highly polished surfaces of the metal from which the die is being cut. The die-makers as a rule work on a block of steel which has been ground and finished until its surface has the appearance almost of a mirror.

PROTECTION FROM INJURIOUS LIGHT OR HEAT RAYS

The National Head and Eye Safety Code lists two general groups of operations in which there is need of protection from injurious radiant energy or, in simpler language, from those light and heat rays which have a harmful effect on the delicate tissues of the eye. The first group includes those processes in which a moderate reduction in the intensity of the visible radiant energy is required, such as: oxy-acetylene and oxy-hydrogen welding and cutting; open hearth, Bessemer and crucible steel making; furnace work; electric resistance welding and brazing; and testing of lamps, involving exposure to excessive brightness. The second group covers processes in which a large reduction of the visible radiant energy is required, such as electric arc welding and cutting.

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* Original specimen of these devices made of wood and whale skin are on exhibit at the American Museum of Natural History, New York City.

In ordinary arc welding where currents ranging from 50 to 200 amperes only are used simple precautions are sufficient for the protection of the operator's eyes and exposed portions of his body. The usual method of protecting the eyes is the use of a face shield or head mask with glass window inserts, the glass of which is of such composition as to absorb the injurious ultra-violet and infra-red rays. When several welders are working in the same room, in addition to the use of face shields or head masks, colored glasses with side protection are worn to protect the eyes of each operator from the arcs of the others. A man working 15 to 25 feet from an arc welder should be protected by wearing goggles.

For the protection of other men working near an arc welder opaque screens should be placed between the arc and the workers, or better still, a booth should be built around the operator, thereby shutting off the arc rays from the surrounding part of the plant. Care must be taken regarding the painting of the interior of an arc welding booth. If a paint that reflects the rays of an arc is used the operator may be subjected to eye flashes from the side and back of the face shield. A paint that will absorb the dangerous rays should be used on the interior of the booth and on all machinery located within it. A simple and satisfactory paint for this purpose is composed of zinc oxide and oil, which may be given any desired tint with lamp black.

In many installations where a large number of small articles are welded, particularly with the automatic welder, instead of building a booth around the operator to protect outside workers, and instead of providing the operator with a mask or face shield, an inclosed cabinet is built around the

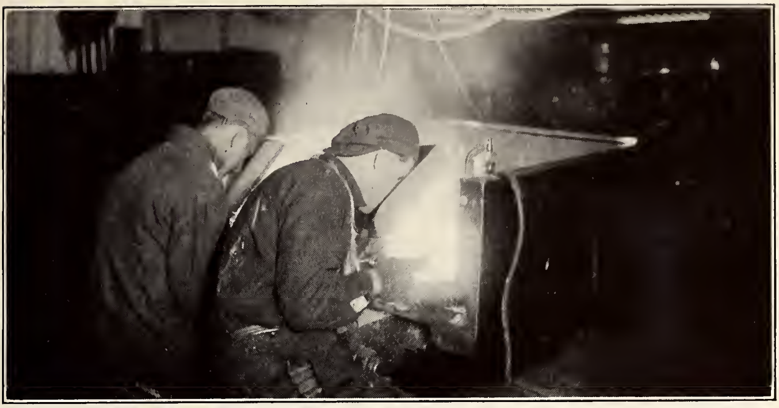


Figure 38.—Welding the engine of an ocean liner. The welder holds the mask for the protection of his eyes in place with the left hand and uses the welding torch with the right.

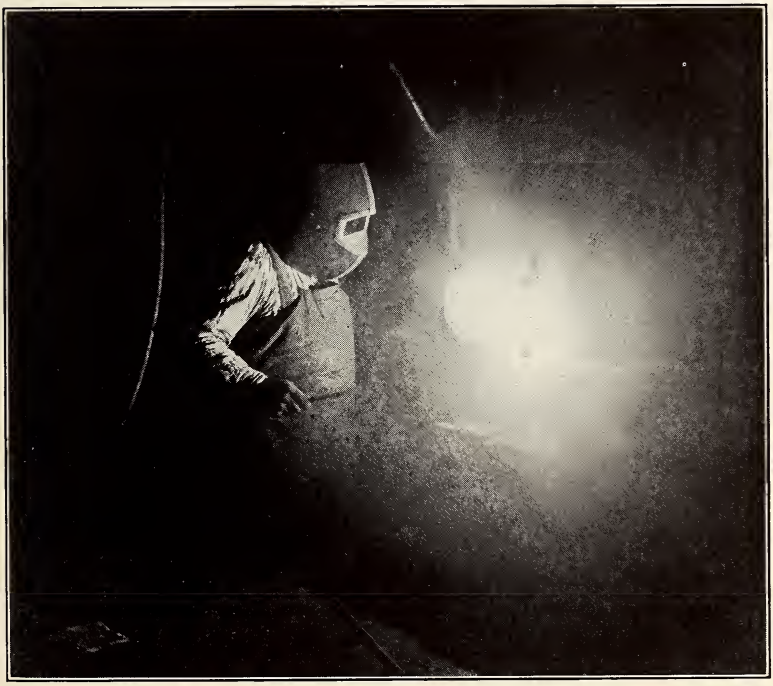


Figure 39.—A light weight and comfortable mask which protects the eyes of the arc welder.

operation itself, and a colored glass protective window, through which the operator can watch the progress of the welding, is provided in the cabinet.

The Safety Institute of America has compiled the following list of operations wherein workmen are exposed to radiation which might have a harmful effect on vision unless protection through goggles with colored lenses is afforded.

Group	Process	Approximate Temperature
Open-hearth steel	Charging machine	3,400° F.
	Steel pourers	2,800° F.
	Plarform men	3,000° F.
	Melters	2,800° F.
Crucible steel	Melting floor	3,400° F.
	Hand pouring	2,800° F.
	All steel pouring	2,800° F.
Bessemer steel	Pulpit operators	3,600° F.
	Blowing steel	3,600° F.
	Pouring in molds	2,800° F.
Blast furnace steel	Tapping	2,800° F.
	Tuyeres	3,500° F.
Wrought iron furnaces	Puddling furnace	2,800° F.
	Gas heating	2,500° F.
	Electric heating	5,000° F.
	Large electric heating	6,000° F.
Welding	Oxy-acetylene cutting	4,000° F.
	Oxy-acetylene welding	4,350° F.
	Light spot welding	
	Heavy spot welding	
	Iron arc welding	5,500° F.
	Carbon arc welding	6,450° F.

The effect of radiant energy upon the eye is described by Dr. Charles Sheard, editor of the American Journal of Physiological Optics, as follows:

"Exposure to ultra-violet light produces severe and painful inflammation of the eye. The usual external symptoms of inflammation, such as redness of the eyes and face, swelling and copious tears, are, however, very moderate or entirely absent. Complete recovery from the effects of such exposure is slow, sometimes covering months or years. In the case of burns of the eye from ultra-violet rays, the symptoms develop from six to eighteen hours after exposure, with severe deep-seated pains in the eyes. The vision is temporarily not affected, but the inability to focus the eye on any object is noticeable. The pains in the eyes and headaches yield rather slowly, and for weeks and even months any attempt at close work, such as reading, leads to blurring of vision, headaches and severe pains in the eyes. In some cases these

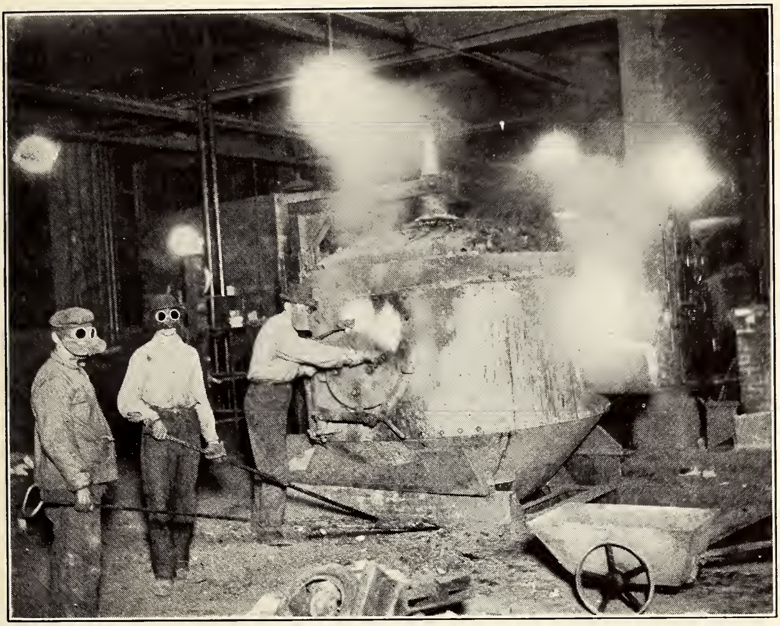


Figure 40.—Furnace men in the Otis Elevator Company wearing masks with colored lenses for protection from intense light and heat.

effects may last for years. Most cases of ultra-violet burns are mild, recovery occurring within a few weeks."

Although there is considerable difference of opinion as to the exact manner in which ultra-violet rays and infra-red rays hurt the eyes, there is a consensus of opinion on this point: whenever an industrial process exposes workmen to intense light or heat, the eyes should be protected by spectacles, goggles or masks—depending upon the nature of the work—with suitably colored lenses. The color of the lens should, whenever possible, be determined by a competent ophthalmologist. When the services of such a specialist are not available, the United States Bureau of Standards, Washington, D. C., or the National Committee for the Prevention of Blindness, 130 East 22d Street, New York City, should be consulted. Reliable manufacturers of protective optical equipment also may be of considerable help in determining

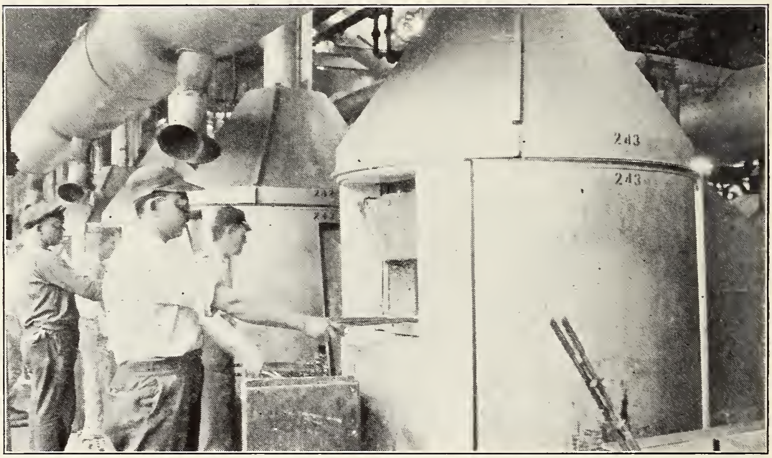


Figure 41.—The fires in these furnaces at the Ford Motor Company develop a temperature of 3,400 degrees; suitable goggles protect the workmen's eyes from the effects of harmful light and heat rays.

the type of lens best suited for use in any particular industrial process involving intense light or heat.

In the case of most of these processes, the heat is so great that unless the parts of protectors touching the face are made of heat-insulating material, the workmen will experience considerable discomfort, if not actual burns of the skin. The use of heat-insulating material in all face masks and goggles required in these operations is recommended, along with any other improvement which will minimize the workmen's temptation to work without the protector, even for a few moments.

PROTECTION AGAINST MISCELLANEOUS HAZARDS

One of the most serious of the many eye hazards in industrial occupations which are not confined to any particular class of work is the danger of flying fragments of metal from the burred or mushroomed edges of hand tools. Were it possible to obtain accurate statistics of the causes of all eye injuries on a national scale, it is probable that the mushroomed tool would be revealed as a far more frequent cause of industrial eye accidents than it is now recognized to be. Accidents from this source are, however, usually listed under such all-inclusive and meaningless designations as "flying objects" or "particle in eye."

Any tool subjected to repeated blows from a hammer or other tool may develop a burred or mushroomed head. Chisels, hammers, swages, flatters, fullers and all breaking-down tools are, however, the tools most likely to develop mushroomed heads if they are not carefully watched and dressed or ground down at the first sign of a tendency to spread. Tools which have been used until the heads have spread and split present one of the most serious eye hazards in industry because a fragment of steel from such a tool may be sent into the eye of a workman at any blow of the hammer. Yet tens of thousands of such tools are in use today on the streets of cities and in industrial plants.

Mushrooming may occur on the finest hand-forged tools as well as on those with cast heads commonly provided in cheap hammers. Since less care to secure uniform results is taken in the manufacture of cheap tools, they are naturally more hazardous than tools of better quality. But it must be borne in mind that the hazard from mushroomed heads is not essentially due to inferior quality alone. In fact, the high carbon in the steel from which many of the most expensive tools are made makes such tools more brittle and, therefore, more likely to chip than other tools.

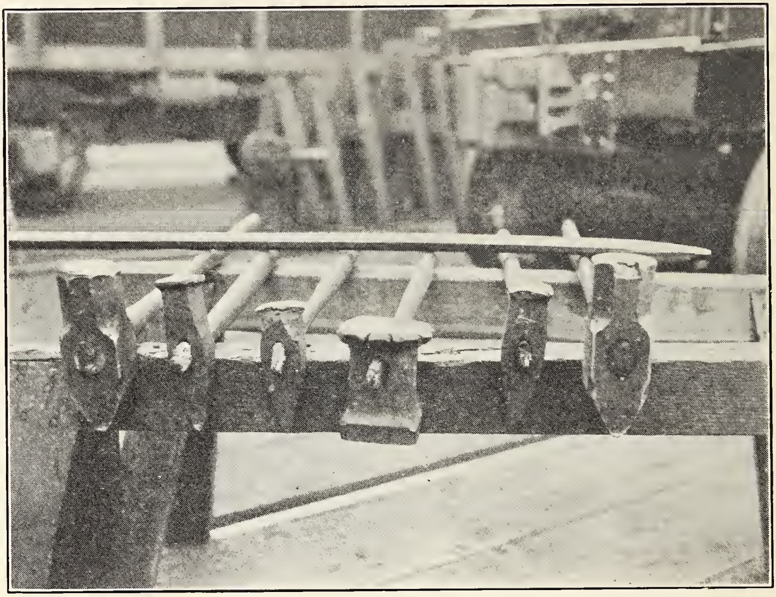


Figure 42.—Tools with mushroomed heads such as these present one of the most serious eye hazards in industry because of the danger of a chip or burr flying from the head of such a tool, when struck, into the eye of a workman or passerby.

Protection against this hazard will be secured only through the wearing of substantial goggles in all operations where there is hammering of one tool against another, supplemented by constant supervision of such work to prevent the use of mushroomed tools. The latter can be assured only by the institution of some regular system for the control of hand tools, such as that described in the chapter on "Engineering Revision." Frequent periodic inspection of tools should be required in every industrial plant and a permanent record kept of the condition of tools. The greatest obstacle to be overcome in guarding against the hazard of mushroomed tools is the century-old habit of workmen to work with tools until the heads are not only mushroomed, but cracked. Because of this long-standing dangerous practice the strictest discipline in the control of hand tools is recommended.

The danger of a flying fragment from a hand tool is almost as serious when the edges of the tool have just begun to spread as when the tool has become fully mushroomed and the edge cracked. Any number of eyes have been injured or permanently disabled by flying fragments from practically new tools. A glancing blow, some slight imperfection in the tool itself, or any one of a number of factors may at any time cause a chip of metal to be struck from the head of a tool.

In the plants of the United States Steel Corporation which has, undoubtedly, more experience with this hazard than any other single employer in the world, there is now in force a rule requiring the reconditioning of hand tools at the first sign of spreading. Safety engineers, safety inspectors and foremen in the plants of the corporation are instructed to watch for this condition among tools. This supervision is supplemented by frequent inspection of the tools that are sent to the blacksmith shop for dressing.

In the opinion of Charles L. Close, Manager of the Bureau of Safety, Sanitation and Welfare of the Steel Corporation, there is an additional danger in waiting for the heads of mushroomed tools to crack before reconditioning them; that is the difficulty—if not the impossibility—of getting a true weld when such a tool is put into the forge. The dirt which finds its way into the cracks of mushroomed tools frequently causes such imperfections in the reconditioning of the tool that the first blow of a hammer on the head of the tool will send one or more fragments of steel through the air.

Miscellaneous Eye Hazards

It has been stated earlier in this publication that wherever industrial workers are employed there is danger of serious injury to the eye. The hazards grouped in the 12 classifications of the national code are, of course, the most common eye hazards. But there are numerous other eye accident hazards not so frequent, but resulting in serious injuries when they do occur. Many of these hazards cannot be foreseen. On the other hand, many can be easily averted by a slight investment in dollars or time. Typical of the latter class are the hazards of the explosion of the water gauge tubes, flying nails, flying belt clips, and the danger of infection of the eye from cutting oils used so extensively in the metal-working industries.

There is little excuse for failure to provide adequate protection against the hazard of explosion of water gauge tubes, for there are now on the market numerous shields designed to prevent the flying of glass in the event of such explosion. In explosion of gauge glasses there is danger of injury to the eye not only from broken glass, but from steam and hot water as well. While accidents of this nature are comparatively infrequent, the records of Massachusetts alone show that in a recent year seven men lost the sight of both eyes from this cause and an eighth workman lost the sight of one eye.

It is generally conceded that gauge glasses should be provided with guards to prevent flying particles of broken glass from striking boiler room workers, but it is not easy to obtain guards which will leave a free and unobstructed view of the water level in cases where the water column is located ten or fifteen feet above the boiler room floor. This is not an uncommon height on several types of boilers. The variety of gauge glass guards of a suitable and efficient nature is limited, and unless the purchaser chances to select one of these few the result is dissatisfaction and the discarding of the guard. Since the breaking of a gauge glass is a common, expected and almost unavoidable occurrence, and since many severe injuries have been received from flying particles of glass, employers should make every effort to secure a proper guard and should be willing to experiment in the endeavor to get one which is efficient and at the same time does not obstruct the view of the water level.

The newer forms of connections for the gauge glass permit more expansion than the types heretofore used, so that glasses will be breaking less frequently. But no device, other than a guard around the glass itself, may be expected to eliminate the very considerable danger incident to the breaking of a gauge glass.

Many safety engineers feel that the only safe gauge glass valve is the quick opening, chain-operated type, which permits the operator to stand some distance from the glass and control the line of steam and water to the gauge by merely pulling on one of two chains to open or close the valves as the case may require. With the screw type of gauge glass valve it is necessary for the operator, in opening and closing the valves, to expose himself to the danger of a glass breaking, and the exposure is of some duration, since it takes considerable time to open or close the two valves.

The discharge outlets of safety valves should be so arranged that there will be no likelihood of any person being scalded or having dust blown into his eyes when the safety valves are open.

Boiler tops should be kept clear of dust, for there are on record many cases of severe eye injuries resulting from the blow of dust from boiler tops into the eyes of workmen.

The danger from flying belt clips is illustrated in an accident reported by The Travelers Insurance Company. The belt in this case, which was joined by means of metal clips, failed at the joint and the clips were expelled with such force that several of them passed through the glass in a window 25 feet away. Such accidents can be averted only by regular inspection and careful maintenance of belts and by the use of non-metallic belt-joining devices. Goggles are, of course, useless under these circumstances. Perhaps the most common cause for the failure of belts at the joints is overloading. The safe working load of a belt may be learned from the manufacturer of the belt and this load should never be exceeded. In too many plants the tension of belts is estimated largely through guesswork. If the belt is installed or tightened during damp or rainy weather excessive strain on the belt is almost sure to result as the belt becomes dry, because leather when wet is much more easily stretched than when it is dry. Belts should be examined and belt tension scale readings taken periodically.

A much more common hazard is that of flying nails, particularly in carpentry work and in packing, shipping and other departments of industrial plants where there is extensive nailing by hand. It is out of the question to ask all carpenters and other workmen to wear goggles whenever they have occasion to drive a few nails. On the other hand, where a workman is engaged throughout the day in hammering nails, the wearing of substantial goggles with side protection should be insisted upon. Where a number of workmen are so engaged in close proximity the hazard is intensified by the danger of flying nails from other men's hammers.

An inquiry among industrial safety engineers as to the causes of flying nails and means of averting this type of accident reveals almost unanimous agreement in the belief that holding the nail improperly or, rather, taking the fingers away from the nail too soon is the principal cause of flying nails, and that education of the workmen in the proper method of driving nails is the most effective means of eliminating accidents from this source. The boiled-down recommendations developed by this inquiry were:

First, that the nail should be held between the finger and thumb until the point of the nail is well into the wood;

Second, an effort should be made always to hit the nail squarely on the head;

Third, the use of hammers with scored or corrugated heads will minimize the danger of flying nails.

A frequent, though not commonly recognized, cause of accidents is the necessity of workmen going from very light to very dark places or vice versa. For instance, a gas or electric meter reader is constantly stepping from bright sunlight into pitch-dark basements and back from darkness into light.

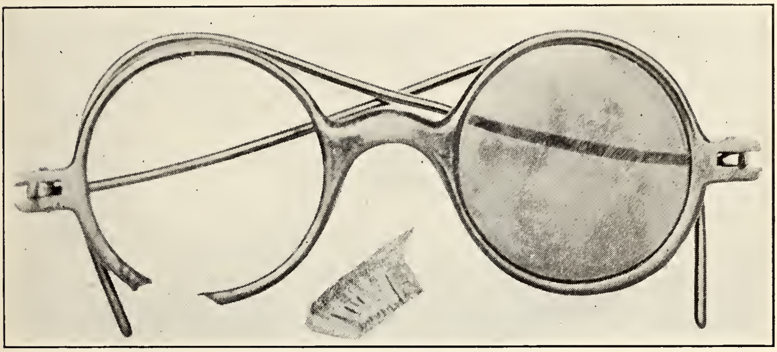


Figure 43.—A hot chip of metal set the celluloid frame of these goggles afire; an employe who happened to have a glass of water in his hand at the time threw the water in the face of the man wearing these goggles, thereby averting what might have been a serious accident. This points to the necessity of avoiding goggles constructed with flammable substitutes for tortoise shell.

A remedy for this hazard, suggested by E. B. Tolsted, a consulting safety engineer, is the use of spectacles with combination clear and shaded lenses, the upper portion of the lens being clear and intended for use in dark places, the lower half being shaded for use in bright light. Such a combination, Mr. Tolsted says, would enable the meter reader to see better in both light and dark places and would alleviate to some extent the constant contraction and expansion of the muscles of the eye necessitated by change from light to dark.

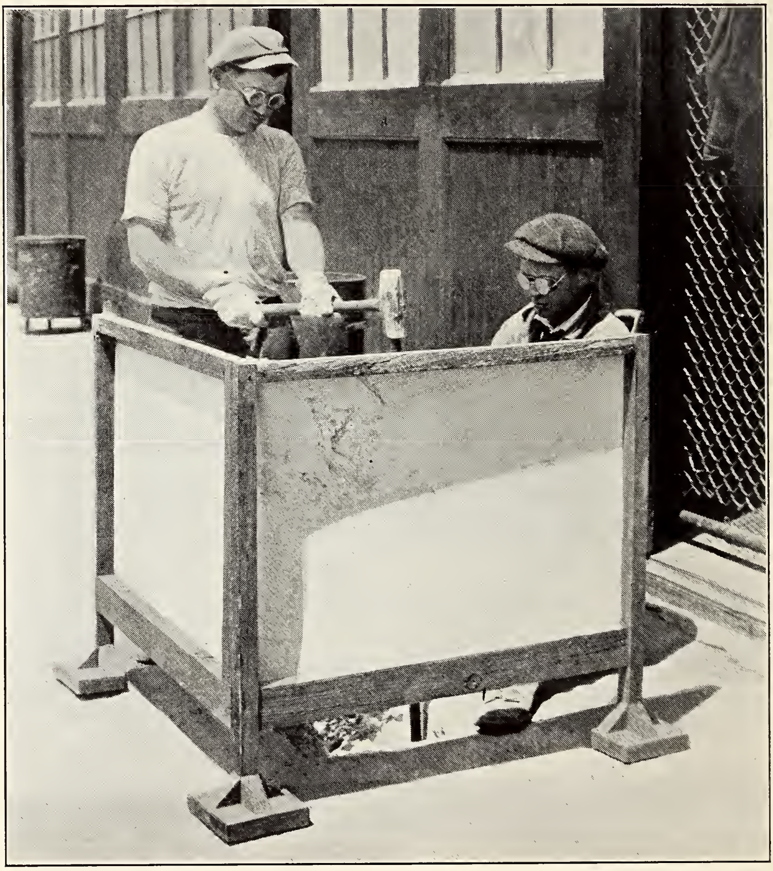


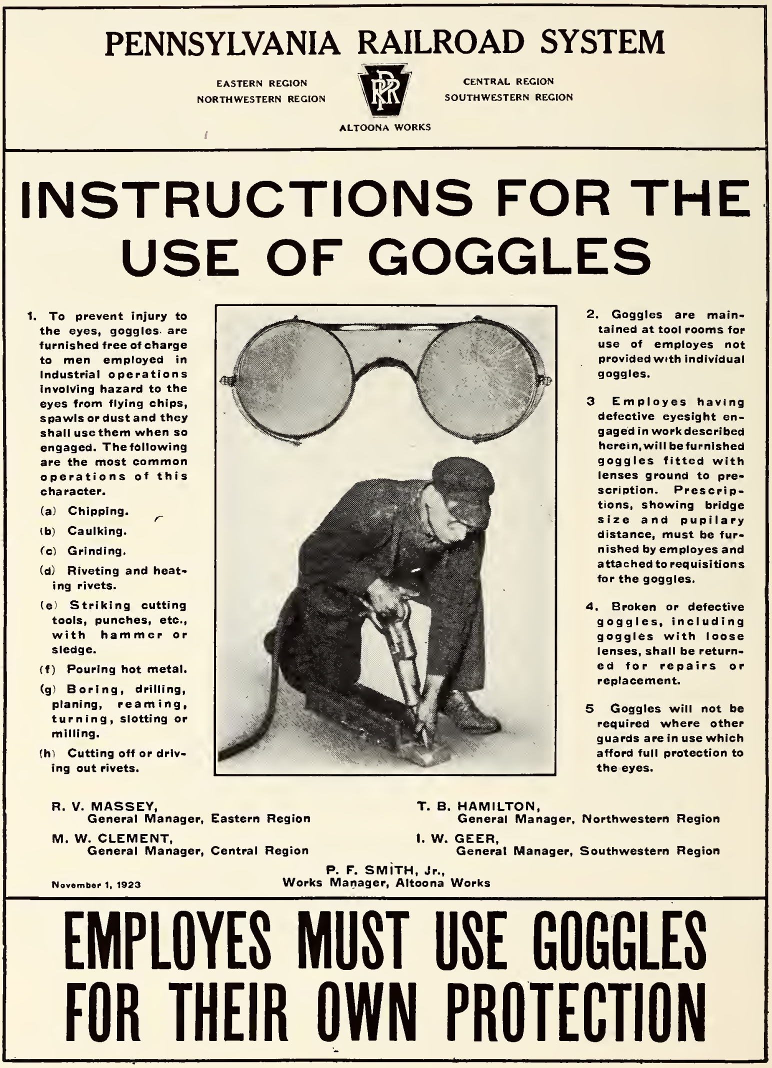
Figure 44.—An instance of 100 percent safety in road repair, an operation where safety is usually neglected. The workmen are protected by goggles and the shield protects passersby.

An enumeration of the miscellaneous eye hazards of all industries would present an almost endless task. The eye accident experience of a shoe company employing more than 8,000 workmen during 1920 and 1921 is herewith presented as an indication of what is probably typical in most other industries which are considered as "non-hazardous" as the shoe industry.

EYE ACCIDENTS—1920 AND 1921—IN SHOE PLANTS EMPLOYING APPROXIMATELY 8,000 WORKERS

Emery in eye	164
Tack in eye	61
Dirt in eye	54
Steel in eye	43
Bruised eye	25
Cut over eye	7
Needle in eye	20
Eyelet in eye	1
Wax in eye	4
Burned eye	3
Glass in eye	2
Ink in eye	1
Scissors stuck in eye	2
Oil in eyes	3
Silicate soda in eye	5
Scale in eye	3
Paste in eye	1
Creosote in eye	1
Solder in eye	3

The 403 eye accidents reported by this company constitute 17% of all the accidents which occurred in its plants during this period.



PENNSYLVANIA RAILROAD SYSTEM

EASTERN REGION
NORTHWESTERN REGION

CENTRAL REGION
SOUTHWESTERN REGION

ALTOONA WORKS

INSTRUCTIONS FOR THE USE OF GOGGLES

1. To prevent injury to the eyes, goggles are furnished free of charge to men employed in industrial operations involving hazard to the eyes from flying chips, spawls or dust and they shall use them when so engaged. The following are the most common operations of this character.
   - (a) Chipping.
   - (b) Caulking.
   - (c) Grinding.
   - (d) Riveting and heating rivets.
   - (e) Striking cutting tools, punches, etc., with hammer or sledge.
   - (f) Pouring hot metal.
   - (g) Boring, drilling, planing, reaming, turning, slotting or milling.
   - (h) Cutting off or driving out rivets.

2. Goggles are maintained at tool rooms for use of employes not provided with individual goggles.

3 Employes having defective eyesight engaged in work described herein, will be furnished goggles fitted with lenses ground to prescription. Prescriptions, showing bridge size and pupilary distance, must be furnished by employes and attached to requisitions for the goggles.

4. Broken or defective goggles, including goggles with loose lenses, shall be returned for repairs or replacement.

5 Goggles will not be required where other guards are in use which afford full protection to the eyes.

R. V. MASSEY,
General Manager, Eastern Region

T. B. HAMILTON,
General Manager, Northwestern Region

M. W. CLEMENT,
General Manager, Central Region

I. W. GEER,
General Manager, Southwestern Region

P. F. SMITH, Jr.,
Works Manager, Altoona Works

November 1, 1923

EMPLOYES MUST USE GOGGLES FOR THEIR OWN PROTECTION

Figure 45.—An instruction card, such as this, posted at strategic points in a plant, not only keeps before employes facts which it is important for them to remember at all times, but produces a desirable psychological effect.

CHAPTER V

FIRST AID TREATMENT FOR EYE INJURIES

The greatest problem in the first aid treatment of eye injuries—as in the treatment of nearly all other injuries resulting from industrial accidents—is that of preventing infection. Machines, tools, raw materials, the products of manufacture, and the atmosphere itself are, of necessity, very often contaminated with oil, grease, sand, dirt, or other bacteria-harboring material. Any wound received in a factory is, therefore, much more likely to become infected than a wound received in the home or on the street. This situation, serious in itself, is aggravated by the difficulty of getting workmen to seek treatment for injuries promptly at regular first-aid stations or medical departments.

Each year there develop among our industrial workers thousands of cases of infected eyes—many of them eventually resulting in total blindness—because of delays in securing first aid or because of self-treatment or treatment (if we may call it that) by fellow-workmen. In the really modern plant, where safety is receiving as serious attention as production, the employes have been educated and trained to report at the hospital for treatment of all injuries—no matter how minor—and facilities have been provided for rendering such treatment quickly, effectively, and courteously. The hundreds of thousands of dollars paid annually as compensation for eye injuries which become compensable cases only through infection are, however, evidence of the fact that in the average plant, and to quite an extent in the very largest and presumably progressive plants, workmen are still in the habit of neglecting slight eye injuries until, through infection, they become hospital cases, or of permitting fellow-workmen to substitute for surgeons or oculists.

In the state of Washington, for instance, in one recent year 59 cases of eye infections caused a loss of 1,024 work days, the payment of $10,446 in compensation, and in fourteen cases permanent impairment of vision. As usual the chief causal factor was "particle in eye." And Washington, except for its lumbering, is hardly an industrial state. Washington's experience is repeated with tenfold severity each year in every state of extensive industrial activity.

What usually happens is this: A fine chip of steel, a particle of emery, a tiny wood splinter, or a grain of sand gets into the eye of a workman. He may be of the old school of shop men who believed (many of them still do) that a wad of chewing tobacco, fresh from the mouth, is a fine antiseptic. He may be of that large class of workmen who think that going to the plant hospital or dispensary with "something in your eye" is a sign of cowardice. He may be by nature a lazy or neglectful individual. Or he may be working in a plant where there is no hospital, no nurse, not even a first aid kit worthy of the name. Under any of these circumstances he does one of two things: decides to worry through the day's work and let his wife or the neighborhood doctor remove the particle, or he asks a fellow-worker to take it out. In either event the tiny wound caused by the particle in the eye becomes infected through delay or by the bungling of an amateur.

In the first edition of this publication, issued in 1917, there appeared a photograph of articles which had actually been used by "shop oculists" for removing particles from the eyes of fellow-workmen. This photograph showed such things as pocket knives, tooth-picks, matches, tweezers, manicure files, shop files, various other industrial cutting tools, and a compass. Although the writers of the present volume had personal knowledge of the use of similar instruments by shop men in recent years, they presumed that these were isolated cases; that the progress of the safety movement in industry had largely done away with the use of such crude instruments for probing such a delicate thing as the human eye. Accordingly, a number of active safety engineers were asked whether the photograph used in 1917 could be considered out of date. Without exception they answered in the negative and pointed out that the photograph did not show the two most dangerous instruments still commonly used by workmen to remove foreign objects from the eyes of their fellows, namely, filthy pocket handkerchiefs and the tongue. The photograph used in the original publication is, therefore, again presented in Figure 46 as evidence of the necessity for thoroughgoing educational work among employes and of providing such first aid facilities and personnel as will encourage the injured workman to apply for treatment promptly.

There are always existent, even in the normal eye, germs which find opportunity for development of serious infections through abrasions which might result from the unskilled use of even a thoroughly sterile probe, and it is of utmost importance that any operation of this nature should be performed by an oculist or physician who may have the opportunity to maintain observance of the eye for possible later developments that might prove disastrous. That is why any workman who sustains an injury of this nature, no matter how slight it may seem to be, should go at once to the company hospital, physician, or nurse, if such there be. There should be first aid kits in charge of foremen or office men who have been instructed in their use, and such persons only should be the ones consulted in any emergency of this nature if no physician is employed by the company.

For the removal of dust and dirt the lids should be gently separated and the eye flushed with boric acid or normal salt solution, followed by a couple of drops of a 10 per cent. argyrol solution or the application of a small bead of bichloride salve, bandaged, and the man sent to the company doctor. This rule also applies to any injuries in which the foreign body has embedded itself in the eye or penetrated it.

All cases of penetrating injuries should be sent to a doctor.

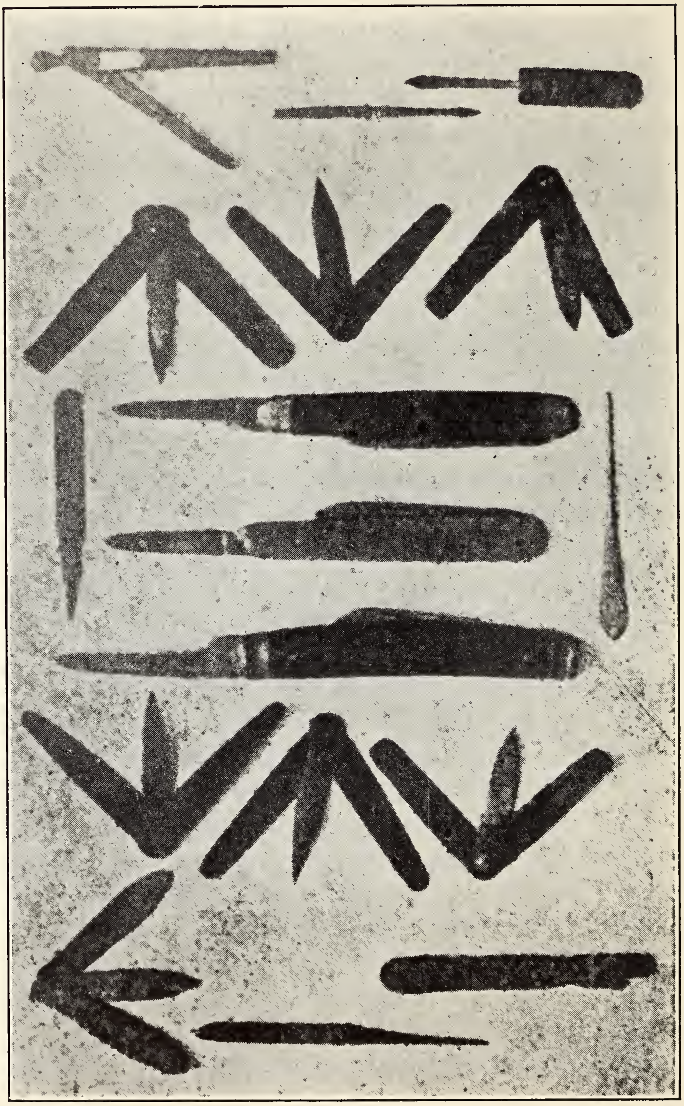


Figure 46.—Articles which have been used by "shop oculists" to remove foreign particles from the eyes of their fellow-workmen.

If the penetrating body is small, it is often impossible for the injured person to tell whether or not there is anything in the eye and the ordinary means of examination used by a doctor may not be able to determine it. In such cases it is of the greatest importance to determine by means of the *x*-ray if there is a foreign body within the globe, for if foreign bodies are not removed, they will eventually destroy vision.

Every factory first aid kit should contain, among other things, sterile gauze and bandages, a syringe for flushing the eye, boric acid, and argyrol.

If there is one regulation above all others which should be in effect in every shop, factory, and workplace of any nature whatsoever, it is *that there shall be no attempt made by any workman to remove from the eye or eyes of a comrade a chip or foreign substance of any kind which may have accidentally lodged therein.* Many corporations have already adopted such a ruling, the penalty for non-compliance usually being immediate dismissal of the offender.

TREATMENT OF ACID BURNS

Because of the pain usually incidental to acid and other chemical burns of the eye, the treatment of such injuries is, fortunately, not complicated by delays and amateurish efforts, such as are described in the foregoing paragraphs.

Wherever workmen are handling acids or chemicals, there should be readily available clean running water to be used for washing hands or irrigating eyes, on which the chemicals may have splashed through accident or explosion. The best first aid treatment in such an emergency is to lay the victim on his back and thoroughly irrigate the eyes, lifting the lids and enabling the water to reach as far thereunder as possible. A small flexible hose from which a moderate jet of water can be directed into the eyes should be at hand. If no better way is evident, the head should be put into a pail of water and the eyes opened so as thoroughly to cleanse them of the acid. If the works are equipped with first aid kits, then apply bichloride salve, bandage the eyes, and *send for the doctor.*

The important thing is to dilute the chemical as quickly and thoroughly as possible.

Eye Burns From Caustic Soda

In the manufacture or use of caustic soda, severe burns are likely to be sustained by the workmen unless constant care is exercised to prevent spattering of caustic soda liquor, and flying of chips of solid caustic soda when opening packages or when breaking up large pieces. The mucous membrane of the eyes and of the mouth is particularly susceptible to injury from burns of this nature.

Dilute acetic acid has been generally used for immediate first aid treatment of burns from caustic soda. Its effect is at once to neutralize the caustic soda and convert it into harmless sodium acetate, stopping its injurious action upon the flesh or material attacked.

This treatment, as extensively used, is prepared from good quality commercial acetic acid by diluting it to an exact content of 2 per cent. actual acetic acid. If the commercial acetic acid be of 30 per cent. strength, one quart of it is added to fourteen quarts of water to give 2 per cent. strength. After this dilution, the acid is analyzed to make sure that its strength is 2 per cent. After the eye is thoroughly washed with this preparation, sweet oil is applied. It is important that no absorbent cotton be used for cleansing the burn, because fibers of that cotton become embedded in the wound.

Bottles containing the dilute acetic acid should be placed at frequent intervals throughout the manufacturing plant, and the workmen trained to use it immediately when needed.

Inasmuch as there are those who feel that dilute acetic acid wash does not measure up to the requirements for treatment of eye burns so successfully as might some other treatment, it should be stated that a 1 per cent. solution of zinc sulphate as a relief measure has been in continuous use by at least one company* for the past thirteen years in hundreds of cases, regarding which its Personnel Director writes: "In the comparatively few cases where loss or impairment of vision has occurred from caustic eye burns, we feel confident that either there was insufficient flushing of the eye with zinc sulphate, or else the flushing was not done soon enough after the injury occurred."

The primary reaction is as follows:

$$\underset{\substack{\text{Zinc}\\\text{sulphate}}}{ZnSO_4} + \underset{\substack{\text{Sodium}\\\text{hydroxide}}}{2NaOH} = \underset{\substack{\text{Sodium}\\\text{sulphate}}}{Na_2SO_4} + \underset{\substack{\text{Zinc}\\\text{hydroxide}}}{Zn(OH)_2}$$

The advantages which are claimed for the use of zinc sulphate over a dilute acetic acid wash are as follows:

(1) Less irritant.
(2) Complete or 100 per cent. reaction, rather than an equilibrium reaction as with acetic acid.
(3) Antiseptic quality of known value.

The details of the procedure adopted for the treatment of eye burns of this nature by the company referred to are described by the safety engineer as follows:

> "We have distributed throughout our caustic buildings, distinctly marked, small boxes containing a 12-ounce bottle of 2 per cent. zinc sulphate solution and one or more eye-cups. These boxes are kept supplied with the solution.
>
> "When a workman receives a splash of caustic in his eye, his first thought is to get the zinc sulphate solution, and we have trained them to keep the location of these boxes pretty well in mind. It is a fact, however, that some other workman, on hearing his cry, will get the solution to him. The eye is thor-

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* Hooker Electrochemical Company, Niagara Falls, New York, Mr. A. L.. Watson, Personnel Director.

oughly washed at the point where the caustic is received, and then the man goes to the dispensary as quickly as he can get there. In the dispensary the man is laid out on the table and more zinc sulphate is applied. Of course, the pain is severe, so we then administer cocaine (2 per cent.), and after this repeat the dose of zinc sulphate. By this time we are pretty sure that the caustic is neutralized entirely, so we apply more cocaine, then olive oil, apply a cold compress, and send him to the physician. The after-care of such an eye-burn is exactly the same as for any burn or irritation of the eye, to permit of proper healing and control of possible adhesions. Ice-packs are kept on the eye while the pain is severe, and this usually makes a patient comfortable.

"Proper and quick neutralization is the essential treatment, and by quick neutralization I mean that received a few seconds after the caustic has entered the eye. Bad burns are the result of waiting until the patient can get to the dispensary.

"For acid burns we lay the same stress on proper and quick neutralization with sodium bicarbonate (c. p.), and follow this with the cocaine treatment and olive oil. For toluol and benzol splashes (where the result is not necessarily a burn, but intense irritation, and this is true with toluol fumes) our treatment is cocaine (2 per cent.) and let the patient stand with his eye open in front of a fan to evaporate the benzol or toluol. I refer particularly to toluol and chlortoluol, with its derivatives, as this is where the intense irritation is found. We also find that steam (properly regulated) is very effective for this purpose."

Acids and Caustics

The acids and caustics most commonly used in industrial processes are: nitric acid, sulphuric acid, mixed acid, hydrochloric acid, hydrofluoric acid, carbolic acid, oxalic acid, picric acid, acetic acid, carbonic acid, hydrocyanic acid, alcohols, ammonia, caustic soda, caustic potash, soda ash, and lime. The method of treating eye injuries from caustic soda was given above. The limits of this publication will not permit similar treatment for each of the other caustics or acids. Any plant using such acids or caustics to any extent whatever should acquaint itself with the safe methods of handling them. The plants engaged in the manufacture of acids and caustics are usually equipped with proper safeguards and first aid paraphernalia, but the plant which uses acids or caustics only occasionally does not, as a rule, give sufficient care to storing, carrying and applying the acid, and is not usually prepared to render prompt and effective first aid.

The National Safety Council's Safe Practices Pamphlet No. 25 presents valuable information concerning first aid in accident hazards from acids and caustics, which may be summarized as follows:

> "The treatment of chemical injuries and illnesses should be left wholly to the physician in charge. A workman's life, however, may depend upon the immediate administration of relief, so first aid remedies, with instructions for their use, should be readily available at all times. Some one person should be made responsible for the quality and quantity of remedies kept in workrooms and at first-aid stations.
>
> "For all chemical burns, physicians recommend the immediate use of clean water in large quantities. Even substances insoluble in water may be mechanically removed from the skin surface by flushing. Some employers have installed shower baths in or adjacent to each workroom, under which a man may stand and be deluged with water

in case of chemical burns. In locations where showers cannot be provided, a flexible water hose or several buckets of clean water should always be easily available.

"The action of acids and caustics on the eyes is very rapid and may cause blindness unless washing with water is immediate. Directing a moderate jet of water into the opened eyes from a small flexible hose is very effective. Other methods are to plunge the head into a vessel of clean water and wink the eyes rapidly, or to allow the water from a bubbler drinking fountain to flow into and flush out the eyes.

"Often large bottles of counteracting solutions are placed on special racks in the workrooms, but precautions should be taken to see that every container is marked in plain, large letters showing the contents and uses of each. If two or more solutions are placed on the same rack, it is well to have them of different color. One solution may be white or colorless, and a harmless vegetable coloring matter may be added to make another red; or different colored bottles may be used.

"It is a general rule that acids neutralize caustics and alkalis, and vice versa, but this rule is not infallible. It is, therefore, preferable to know the best neutralizer for each chemical."

First Aid for Chemical Burns

(a) For acid burns,—nitric, sulphuric, mixed, hydrochloric, acetic, oxalic, and picric (for oleum, first wipe off oleum with a clean cloth),—bathe freely with water and apply a saturated solution of bicarbonate of soda.

(b) For alkalis,—caustic potash, caustic soda, ammonia, lime, and soda ash,—bathe freely with water and then apply a 2 per cent. solution of acetic acid.

(c) For hydrofluoric acid, bathe freely with water and then with dilute ammonia water.

(d) For carbolic acid burns, wash at once with water, then with alcohol or a solution containing equal parts sweet oil and lime water.

(e) For hydrocyanic acid, wash with water, then with hydrogen peroxide.

How One Company Made First Aid Pay

Appreciating the difficulties with reference to eye work usually encountered in industry and the difficulty of getting all workmen who are exposed to abrasive materials to wear their goggles while engaged at such work, the R. K. LeBlond Machine Tool Company of Cincinnati, O., decided to incorporate an eye room in its hospital. This subdivision of the hospital is primarily used for the removal of foreign bodies from the eye, and the subsequent treatment, such as congestion and the abortion of corneal ulcers, which often follow after a foreign body has become adherent to the eye.

The eye room is simply a room 4 x 4 x 8 feet, the inside of which is painted black. It contains a shelf with the different eye solutions, an adjustable chair, and special overhead illumination. The installation of such a room does not require any major structural changes in the building.

"The benefits accruing from such an eye room are many," it is pointed out by Sanford De Hart,* Director of the Safety and Hospital Department of the company, "among which might be mentioned the privacy it affords for the extraction of foreign bodies, and the very excellent opportunity to impress upon the patient the importance of wearing goggles. I know of no more opportune time to talk goggles to a workman, and of no more receptive auditor than a man who has just had a piece of emery extracted from his eye. The decrease in the number of men reporting to our hospital for this type of injury is indicative of the soundness of this form of safety education. An eye room eliminates the possibility of the attendant inadvertently putting the wrong solution in the eye, since only medicines and appliances used for the treatment of eye cases are kept in this room."

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* In an article in Industrial Management, July 1, 1921.

Eye Cases Reduced From 5,000 to 900

An idea of the economic value of a special room for the treatment of eye injuries may be had from the fact that during the first year following the installation of such a room in this plant the number of cases of foreign bodies in eyes was reduced from 5,016 to 1,302 and that in the next year the total was further reduced to 979.

Compensation Reduced From $1,000 to $3

During the year preceding the installation of the eye room severe eye cases were referred to an eye specialist some eight miles from the plant. During that year there were 862 hours or 107 working days lost from this cause alone, at a total cost of $1,052 for compensation and specialists' fees, not including production losses. The company has normally 1,000 persons on its payroll. In the first year after the introduction of the eye room lost time due to eye injuries was reduced to 436 hours for the year, and the cost to $412. The second year lost time was reduced to 78 hours and compensation to $26. Up to September of the third year the time lost was still further reduced to 70 hours, and the cost was only $3.50. This was accomplished without any changes or additions to the hospital personnel.

A dark room such as that installed by the LeBlond Company can be built and equipped for $300. It can be used for the additional purpose of examining employes' eyes for refractive defects or diseases.

CHAPTER VI

THE CORRECTION OF DEFECTIVE VISION

In the evolution of our modern industrial world the greatest attention was given first to the improvement of machines, then to the conservation of raw materials and the utilization of by-products; it is now being directed to the development of greater efficiency in the industrial worker. Ever since the termination of the World War labor costs have been increased far out of proportion to the increased cost of machinery, raw materials or capital investment, with the result that employers generally are giving more serious attention than ever before to the many factors which determine or influence the productivity of the individual worker. It is in this latter phase of industrial management that we are brought face to face with the important part that vision plays in industrial efficiency.

There is no longer any need to speculate on such questions as: the extent to which defective vision exists among men and women in industrial occupations; the extent to which defective vision interferes with efficiency; or the extent to which poor vision increases the frequency and the severity of industrial accidents. All of these questions have been answered for industry as a whole by investigations in scores of plants of diversified operations. They are questions which should receive the serious consideration of every individual employer. And the employer who is not convinced through the experience of others of the necessity of discovering every case of defective vision among his employes and insisting on its correction owes it to himself, his business associates, and his workmen to seek in his own plant the answers to the aforementioned questions.

The Extent of Subnormal Vision in Industry

If one were to say to the average employer today, "One out of every two employes in your shops, offices, and stores cannot see clearly what he is doing," the employer would be astounded, or he would simply refuse to believe the statement unless it were supported by the records of examinations by physicians or oculists. And yet this statement is not only true, but extremely conservative, except for the comparatively few establishments in which the eyes of every employe have been examined and those of subnormal vision corrected by the use of glasses or by medical or surgical treatment.

Some of the larger and more progressive industries have in recent years begun to examine the eyes of all employes and of all applicants for employment. This is what some of them found:

At the plants of the William Cramp & Sons Ship and Engine Building Company, out of 6,142 men examined, 3,111 or 51 per cent. had defective vision; of this number 2,991 had defective vision in both eyes, and only 120 were affected in but one eye.

Dr. Harry S. Reynolds of the Service Department of Cheney Brothers, silk manufacturers, reports that in the examination of 1,000 applicants for employment in a silk mill by Snellen and Jaeger tests 52 per cent. were found to have deficient eyesight. The following table shows the comparative incidence of visual defects at different ages, as found among these silk mill workers:

VISION EXAMINATION OF EMPLOYMENT APPLICANTS BY SNELLEN AND JAEGER TESTS

Abnormal vision in	52.0	per cent. of	1,000 total.
“ “ “	44.1	“ “ “	840 under 40 years of age.
“ “ “	43.3	“ “ “	519 males under 40 years of age.
“ “ “	45.1	“ “ “	321 females under 40 years of age.
“ “ “	33.8	“ “ “	272 applicants in 2d decade.
“ “ “	43.8	“ “ “	374 “ “ 3d “
“ “ “	59.2	“ “ “	194 “ “ 4th “
“ “ “	87.3	“ “ “	79 “ “ 5th “
“ “ “	100.0	“ “ “	60 “ “ 6th “
“ “ “	100.0	“ “ “	20 “ “ 7th “
“ “ “	100.0	“ “ “	1 applicant “ 8th “

At the plant of the Bausch & Lomb Optical Company, 50 per cent. of all new employes were found, on examination, to have some eye defect. "Needless to say," writes Max Paser of this company, "every person employed by this company has his eyes carefully corrected before being put to work."

Percentage of Defective Vision Among Workmen

The surprising experiences of a car building plant in the Middle West, which in 1922 began for the first time to examine the eyes of the men in its employ, are indicative of the conditions that undoubtedly exist today in thousands of other plants which have not considered it necessary to look into the state of their workmen's eyes. This company found on its payroll 125 men each having a glass eye, most of whom had been passed by the Employment Department through failure to recognize the artificial eye. In one case it was found that a workman had so little sight that he had been brought to the gate by a fellow-workman each day for years, and had been doing his work by sense of touch rather than by sight. Of 377 workmen whose eyes were examined during two months in 1923 at this same plant, 205—or 54 per cent.—needed glasses. During the first six months of 1923 more than 2,600 of the 4,700 men in this plant were given goggles with corrective or individually prescribed lenses.

It should be noted that these four companies, in different sections of the country, in greatly divergent industries, conducting their investigations independently and at different times, found almost identical conditions, namely, that half of their workmen had seriously defective and uncorrected vision. In each of these plants one worker out of every two could not see clearly what he was doing, where he was going, or what was passing before him.

The extent of sub-standard vision among industrial employes reported by Dr. Earle B. Fowler in his chapter on eye conservation in the American Engineering Council's report on "Waste in Industry," is even more marked, as shown in the following table which was prepared by collating the figures given in Dr. Fowler's report:

	Number Examined	Number with Defective Vision	Per cent. Defective
Garment workers.........	2,906	2,163	75
Miscellaneous factory and commercial house workers	10,000	5,000	50
Typewriter plant workers ..	675	392	58
Paper-box factory workers..	3,000	2,340	78
Totals...........	16,581	10,195	(average) 61

The investigations on which Dr. Fowler's report is based indicate that the percentage of defective vision is highest among the very workers who have the greatest need of good vision. For example, in the plants of the Whiting Davis Company where a great deal of close fine work is done, the eyes of all employes were examined, and it was found that only 8.4 per cent. of the employes did not need glasses; 8.3 per cent. wore glasses which were satisfactory; and 83.3 per cent. needed new glasses.

While the discovery of such conditions within their plants naturally comes as a shock to most industrial executives, they are conditions easily accounted for. Nature supplies long-range outdoor eyes which, until comparatively recent years, were seldom called upon for close application. Modern life demands that the eyes be used more intensely, and for longer periods of time. A further explanation of the prevalence of defective vision to such a marked degree is the fact that many foreigners—at least during their first few years in this country—are afraid to go to an eye clinic or hospital for an examination of their eyes, and instead yield to the temptation to buy spectacles from the ten-cent store, the push-cart or the itinerant peddler. Another factor in this situation which must be taken into account is the traditional dislike for glasses by a certain type of workman who feels that wearing glasses is an indication of senility.

The Principal Eye Defects

By far the great majority of eye defects discoverable among industrial workers are imperfections in the refractive powers of the eye. These are not to be confused with eye diseases, although refractive defects may be the result of eye diseases. The four visual defects most common among working men and women, yet little understood by laymen, are those which produce near-sight (myopia), far-sight (hyperopia), astigmatism, and presbyopia, the last a condition of the eyes due to increasing years. Failure to correct these defects, the medical profession is agreed, is often the cause of disturbances in the nervous or digestive system or of other forms of serious sickness apparently unrelated to eye strain.

FAR-SIGHTEDNESS (Hyperopia).—This is an error of refraction in which the parallel rays of light from distant objects are brought to a focus behind the retina when the eye is at rest, i.e., with accommodation completely relaxed. Divergent rays from near objects are focused still farther back. The far-sighted eye can focus light from distant objects by making the crystalline lens thicker but can only focus or more nearly focus light from nearby objects with excessive ciliary muscle strain. Far-sightedness is one of the most frequent errors of refraction and is congenital. Since the far-sighted eye must be under constant strain in attempting to secure distinct vision, the ciliary muscles which determine the thickness of the lens ultimately lose their power. Only through careful examination by an eye specialist can the exact degree of far-sightedness be determined. Whenever any marked degree of uncorrected far-sightedness exists, close work is impossible for any length of time except under great eye strain and then usually during the earlier years of productive life. The manifest far-sightedness (that which cannot be overcome by accommodation) increases with age. When the accommodative efforts are unequal to the task imposed by near work there usually results weak sight and eye strain. The accompanying physical discomfort is manifested in headaches, neuralgia, inflammation of the eyes, watering of the eyes, an abnormal intolerance of light and other symptoms which may be the result of far-sightedness.

NEAR-SIGHTEDNESS (Myopia).—This condition exists when parallel rays are brought to a focus in front of the retina instead of exactly on the retina. Usually, the near-sighted eye has distinct vision for close work, although when a high degree of myopia exists the point of distinct vision may be very close to the eye. Usually myopia is the result of a lengthened eyeball. Dr. C. H. May, in "Diseases of the Eye," says: "The determining causes [of myopia] are associated with the demands which civilization and education make upon vision. It is rarely congenital, though there is often an hereditary tendency for its development. It is an acquired change which commences at an early age when, during the developing period, the eyes are used excessively or improperly for near work. Its occurrence is in direct proportion to the standard of education.

Industry is not usually responsible for the beginning of myopia, but may be responsible for its progression, especially in young employes. Myopia is often of low degree in boys and girls below the minimum employment age, but usually the error increases in industries requiring close use of the eyes. When myopia exists in any degree, correction by properly fitted glasses should be made. Correction usually results in greater individual efficiency through improved mental and physical conditions. This is equally true in the case of far-sightedness.

The importance of correction from the standpoint of industry depends upon two factors: The character of the industry and the degree of myopia. So far as the first is concerned, persons with a moderate degree of myopia may work without discomfort at certain occupations even though they may require close application: in the second, persons with even a moderate degree of myopia may suffer from pain, fatigue and sensitiveness to light.

There can be no question that, in general, the efficiency of an individual, both from his own and his employer's standpoint (and, after all, these may be considered identical), will be increased by correction made by means of glasses prescribed by a competent eye specialist and ground by an equally competent optician.

ASTIGMATISM.—This is a defect of the eye in which light rays in different meridians are not brought to the same focus. It is usually due to irregularities in the shape of the cornea of the eye and is often caused by changes in the cornea from accident or disease, although the irregularities are also often congenital. Oculists tell us that there is some degree of astigmatism present in every eye, although the amount may be so slight as to give no inconvenience.

Dr. May says: "There is always a diminution in the acuteness of vision both distant and near, varying with the degree and variety of astigmatism; it is least with simple astigmatism,* more with compound astigmatism,† and most with mixed astigmatism.‡

"There is usually considerable *asthenopia* (weak sight or eye strain), especially upon the use of the eyes for near work. These symptoms are similar to those occurring in far-sight, but are apt to be more pronounced or continuous. They vary with the degree and variety of astigmatism, the amount of near work done, and especially the state of the patient's health. A small amount will, for instance, often give rise to severe nervous symptoms in a young, delicate, neurasthenic individual. The involuntary accommodative efforts of the ciliary muscle, made to diminish the effects of the error, cause continuous eye-strain and explain the frequency of asthenopia."

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* Simple astigmatism, in which one meridian is normal and the other is near-sighted or far-sighted.

† Compound astigmatism, in which both meridians are either near-sighted or far-sighted but unequal in degree.

‡ Mixed astigmatism, in which one meridian is near-sighted and the other far-sighted.

It is now the opinion of most ophthalmologists that early refraction, together with the use of proper glasses, is necessary in astigmatism if its evil effects, not only in impaired vision but in impaired general health, are to be avoided. Astigmatism can be measured only by trained eye specialists. Its measurement and correction are comparatively recent discoveries. While there may still be controversial opinions concerning eye troubles as the cause of certain systemic diseases, there is accord in the knowledge that astigmatism is one of the principal causes of eye-strain and of much inefficiency. Its relief will, as in the case of far-sightedness and of near-sightedness, reduce the accident hazard of industry, increase the production, prolong the productive life of the individual workman, and improve the quality of his product.

PRESBYOPIA.—This is long-sight and impairment of vision due to advancing years or to old age. Presbyopia is a condition of eyesight which very few individuals who read much can escape in middle life. Usually its effects become apparent between the age of forty and forty-five, although in some cases they may appear earlier or later.

The presbyope is compelled to hold reading matter, sewing, and other forms of near work farther away than the usual distance, making such efforts uncomfortable. With recession of the near point beyond the usual situation, the print becomes pale and indistinct, and fine type can be read only with great difficulty. A person in this condition is apt to use strong illumination; this produces contraction of the pupil, and thus improves the definition by diminishing the circles of diffusion. But if the condition be uncorrected, he suffers from weak sight or eye-strain, pain, fatigue, watering of the eyes, dimness of vision, and irritation of the lids, all of these symptoms being more marked with poor light or at night with artificial illumination. Presbyopia has no effect upon distant vision. Presbyopia uncorrected results in poor vision for near objects. It may be corrected by the use of properly fitted glasses. The condition is, however, progressive and so glasses with stronger power must be supplied from time to time.

OTHER EYE DEFECTS.—Other eye defects may be due to fatigue of the ciliary muscle, a lack of balance of the motor apparatus of the eye, crossed eyes, etc. The four discussed, however, cover most of the cases. It is to be noted that many times there may be a combination of two or three of these defects.

The Effect of Poor Vision on Production Efficiency

The direct effect of subnormal vision on the quantity and quality of production, on the amount of spoilage of raw materials and finished products, and on the general contentment of the worker is so evident as to need little elaboration here. A few typical instances, however, may be of interest:

In one of the plants of Cheney Brothers a comparative study was made in 1922 to determine accurately whether, and if so to what extent, the correction of defective vision results in greater productivity in the individual worker. Glasses were newly worn by all of the operatives studied, and their production and efficiency were compared over periods before and after obtaining the glasses. The results of this series of highly interesting and truly scientific tests were reported to the National Committee for the Prevention of Blindness by Dr. Harry S. Reynolds, of the Service Department of Cheney Brothers.

The first study compared the production of 13 velvet weavers during a three months' period before they wore glasses and a three months' period after they had obtained glasses; at the same time and under identical conditions a study was made of the production of another group of velvet weavers who had not been treated for defective vision, nor were they known to have any visual faults. During the second three months' period the velvet weavers of presumably normal vision, whose eyes had not been treated, showed an average individual improvement in production of 1.19 per cent.; during the same period the weavers whose defective vision had been corrected by glasses showed an average individual improvement in production of 4.21 per cent. A third group of velvet weavers who were wearing glasses for the first time in this same study showed average individual improvement of 3.32 per cent. as against the 1.19 per cent. improvement of the weavers whose eyes had not been treated.

A study, along different lines, of the relative productivity of quillers and beamers (other silk mill workers) showed average individual improvement of 6.3 per cent. after the wearing of glasses, as compared to a similar period before their defective vision had been corrected.

Still another study of seven miscellaneous operatives in the same mill and under an entirely different, but equally careful system of production measurement, showed an average gain of 11.13 per cent. in production efficiency.

Commenting on these findings, Dr. Reynolds said: "These studies, taken in the aggregate, are certainly indicative of favorable improvement after treatment of refractive errors."

The National Safety Council, in its Safe Practices Pamphlet No. 50 on "Practical Methods For Reducing Fatigue," says: "Despite good illumination systems, eye fatigue occurs. There are instances where vigorous workers between 45 and 50 years old, who were apparently tired out at quitting time daily and whose earnings fell off without apparent reason (in some cases as much as 20 per cent.), later exceeded their best record of production after being properly fitted with glasses."

The indirect effects of defective vision on production efficiency, though less apparent, are perhaps even more far-reaching than the direct or apparent effects. Consider the one matter of fatigue. Frank B. Gilbreth, after many years of intensive study of this subject, estimates that the loss to American industry in production alone, resulting from the fatigue of workers, is more than twenty cents per day per worker, or more than $2,000,000,000 per year. This is at least four times the fire loss of the United States, and like the fire loss it occurs year after year.

No one will deny that poor vision—whether it be due to insufficient light or to uncorrected eye defects—is one of the principal factors in causing fatigue, not only of the eyes but of the entire body.

Lowered production is the most easily recognized result of fatigue. Another is slowness to respond to stimulation. A workman who is fatigued does not see, does not hear, does not understand, and does not act with his accustomed speed. For example, he may be working at a punch press and actually see the plunger descending upon his fingers, yet slowness of reaction or of comprehension due to tired nerves will result in his failure to remove his hand in time to avoid losing several fingers.

The Effect of Defective Vision on Accident Frequency

Aside from the accidents caused by fatigue due to defective vision, are the accidents resulting directly from faulty vision. While statistics are not available to show the relationship between defective vision and the frequency of accidents, there is no doubt that poor vision is often the cause of accidents which are attributed to "carelessness."

The writers believe, in fact, that in the case of many industrial concerns the reductions in accidents reported in recent years are due in large measure to the greater attention which is now being given to the condition of the eyes of applicants for employment and, in many plants, to the eyes of those employes who were engaged before the inauguration of this practice.

Responsibility for Correction of Vision

Modern life requires close use of the eyes by an ever-increasing number of those gainfully employed, and the very requirements of employment seem to cause defective vision in a proportionally larger number of people. There are two major steps which must be taken to remedy this situation: first, conditions which lead to eye strain and resulting defective vision must be changed; second, all possible remedial measures must be taken for those who are now suffering from eye defects whether congenital or acquired.

As an example of the first: illumination sufficient and without glare must be provided in factory, school, store, and home so that there shall be a minimum amount of eye strain. Educational methods must be so modified that myopic conditions will decrease and fewer boys and girls enter gainful employment at adolescence with a permanent vocational handicap. As an example of the second, correction of refractive errors, treatment of diseases and operations where necessary will do much to relieve existing conditions. It is true that both of these require large expenditures of money, but such expenditures must be regarded as investments made to insure the health, happiness, and efficiency of the community.

How shall the expense be distributed? Shall the individual bear it? Shall it be a charge upon the public treasury, or a charge upon industry? Probably a distribution among the three. It is, however, within the province of this bulletin to discuss the matter from the standpoint of the employer only. There has been enough experience in American industries to show that the correction of defective vision is a paying investment. The experiences of three employers in investments in the correction of sub-standard vision are described by Dr. Fowler in "Waste in Industry."

At the Hood Rubber Company an ophthalmologist has been employed for three years on a part-time basis, giving three hours a day almost entirely to eye examination and visual correction. The mechanical work is carried out by a manufacturing concern that sends a representative to take frame measurements and adjust delivered glasses, the Hood Rubber Company paying for the glasses at less than the usual retail rate and charging the employe the same, in weekly payments where necessary. The entire expense for the surgeon, however, is carried by the firm. Employes in whom a condition of sub-standard vision is determined at the time of examination for employment or any subsequent examination, are advised to avail themselves of this service, and most of them do, but there is no compulsion and no exclusion from employment because of sub-normal acuity. All employes reporting at the plant hospital complaining of symptoms that might be due to eye troubles are referred to the ophthalmologist. The total number supplied with glasses is about 1,000 per year.

At the Cheney Silk Company and at Sears-Roebuck & Co. the method is somewhat different. Employes whose vision is below standard or who complain of symptoms of eye troubles are sent to an ophthalmologist. While the employe pays for this service it is rendered at a greatly reduced rate. This arrangement is made because of the large number of persons involved, and the fact that the companies assure payment. Glasses are supplied at wholesale or reduced rates, on the installment plan where necessary. The time loss incident to the examination is at the companies' expense, but this has been shortened to a probable minimum.

In the case of each of these companies, Dr. Fowler reports, the observations of foremen and superintendents, and the comments of the workmen themselves have been such as to lead to a continuation of the service year after year. In addition to these, similar services are rendered to employes with defective vision by the Pennsylvania Railroad, the United States Steel Corporation, The International Harvester Company, the General Electric Company, and numerous other concerns whose business judgment in such matters is unquestioned.

Two of the most unique eye clinics in industry which have come to the attention of the National Committee for the Prevention of Blindness are those of the Joint Board of Sanitary Control of the women's garment trades of New York City and of the Delaware and Hudson Railroad Company, the former because it is self-supporting and at the same time renders service at charges within the reach of the poorest workman, and the latter because it is a traveling clinic in which the eyes of every employe of the railroad are examined every two years. In 1908 this railroad converted a passenger coach into an Eye Clinic Car which has been used ever since exclusively for this purpose. At one end of the car a reception or waiting room is provided with seating capacity for six

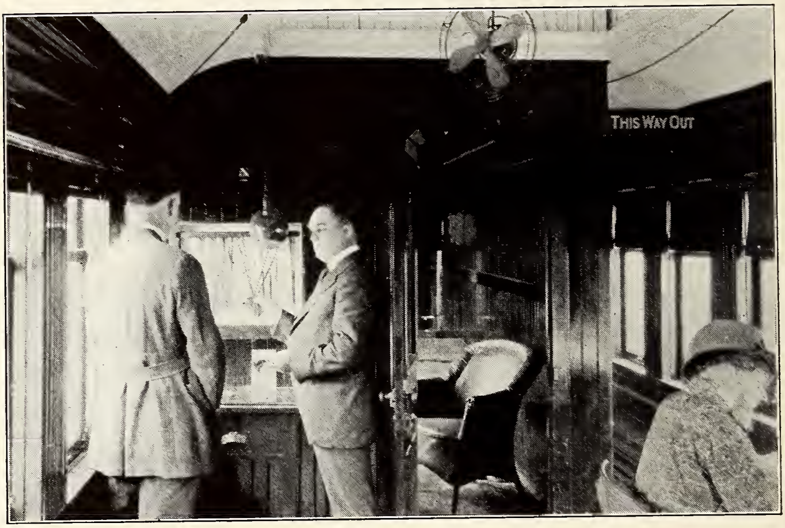

Figure 47.—One large railroad company examines the eyes of each of its employes once every two years by means of this eye clinic car, in charge of an experienced oculist, which is sent over the lines of the road regularly, stopping at each point.

or eight persons. A partition separates the waiting room from the main office. The office contains a desk and two chairs for the use of the examining oculist and his secretary. An abundance of light being desirable, the main office is finished in light grey.

Standard spacing for vision tests is provided. The test letters are slotted, enabling the examiner by means of a cord to move the cards up and down to guard against memorization. In the main office there is also a dropleaf table, 3 ft. long and 2 ft. wide, which is attached to the partition separating the main office from the doctor's private office, and it is upon this that the skein color tests are conducted; cards for close reading are also kept on this table.

The dark room occupies a space at the side of the car, partitioned off from the main office and is about 20 ft. long and 5 ft. wide. This dark room is equipped with electric and oil lamps showing the various color indications.

The private office is separated from the main office by a partition and door, space being allowed for an aisle or passage way for use as an exit to the door at the other end of the car. The private office contains the files, papers, and instructions pertaining to the business at hand.

It is clear that most large industrial concerns and public utilities now recognize their responsibility—from either a humanitarian or a purely economic point of view—for the detection and correction of faulty vision among their employes. This is not, however, as generally true of smaller enterprises.

Recommendations

It is recommended that the eyes of all applicants for employment be examined and that the correction of refractive errors be made a condition of employment, but that the employer exert every possible means compatible with good business to enable the employe to secure glasses at a moderate cost and, when necessary, by paying for them on the instalment plan. The eyes of present employes also should be examined at least once every two years. It is particularly important that the eyes of men and women who are engaged in close or exacting work be carefully examined on employment and periodically thereafter.

It is urged that the condition of the eyes of employes—even where vision has been corrected by glasses—and the visual requirements of the particular work that the employe is to do be considered in assigning each worker to his job. The International Harvester Company does this through Job Specification cards which are placed in the hands of the medical and employment departments. A card for each worker in his department is also given each foreman. The works doctor, the employment clerk or manager, and the foreman, each know that a person engaged for any particular job must meet certain physical requirements; if the medical examination or subsequent observations by either the works doctor or the foreman show an employe unfit for certain work because of the condition of his eyes or indicate that the condition of his eyes in combination with the visual requirements of the job predispose him to accident or to serious impairment of vision, he is returned to the employment department for transfer to other work.

"This," writes a representative of the Industrial Relations Department of this company, "is, in my opinion, the biggest contribution that we have made recently to the prevention of blindness and accidents involving other injuries."

CHAPTER VII

DISEASES AFFECTING THE EYES

Occupational diseases affecting the eyes may be divided roughly into four groups, as follows: those resulting from the use of certain industrial chemicals; those resulting from exposure to injurious radiant energy; nystagmus; venereal disease, and communicable eye diseases. Venereal disease is considered here as an industrial disease, not in the sense of a disease brought on by engaging in any industrial occupation, but because the unhygienic conditions under which employes are permitted or compelled to work in certain plants confront the average industrial worker with a much higher degree of exposure to venereal disease than exists outside of industry.

Those Resulting from Use of Industrial Poisons

A complete list of the poisonous chemicals and minerals used in industrial processes which affect the eyes, the conditions resulting from exposure to these poisons, and the occupations which offer such exposure will be found in Appendix I.

Those Resulting from Exposure to Radiant Energy

The operations wherein workmen are exposed to radiation which may impair sight unless protection is afforded the eyes through suitable colored lenses or other devices, the symptoms following exposure to injurious light and heat rays, and the means that should be taken to avert such injury are discussed briefly in Chapter IV. It is appropriate here, however, to consider what is perhaps the best known case of an eye disease caused by repeated exposure to radiant energy, namely, glass blowers' cataract.

It has been recognized for many years that glass blowers are particularly susceptible to a special form of cataract of the eyes. The cataract almost always appears first in the left eye, which is the more exposed to the light. When it appears first in the right eye it has been found that the glass blower has been in the habit of turning this eye toward the oven. Doctors F. H. Verhoeff and Louis Bell, who have devoted many years of intensive study to this subject, in a paper read before the Illuminating Engineering Society* declare that the great frequency with which glass blowers' cataract occurs, its relatively uniform type, and the fact that it occurs first in the more exposed eye, show clearly that it is chiefly due to the action of radiant energy on the eye itself. This is supported also by the fact that the cheek shows a more marked area of discoloration on the side of the first affected eye.

Nystagmus

Nystagmus may be found among those workers who year in and year out subject their eyes to abnormal and unaccustomed motions. The miner develops nystagmus through constant imperfect fixation of his eyes on poorly illuminated objects; the chauffeur acquires nystagmus by the constant watching of traffic without complete fixation; the compositor by watching the type which he is setting; the paper hanger and painter by following their brushes, in conjunction with the fact that their bodies are often thrown out of a vertical position, thus causing more strain on the visual apparatus. For like reasons locomotive engineers, draftsmen, jewelers, typists, textile workers, and others may acquire nystagmus.

This disease is characterized by continual short, rapid and rolling involuntary movements of the eyeball. A person so afflicted usually complains of objects dancing before his eyes, headaches, dizziness and general fatigue, all of which symptoms clear up quickly if a change of work is made. The involuntary movements of the eyeball characteristic of nystagmus may also be induced by occupational causes affecting the eyes through the central nervous system or by some extraneous cause. Nystagmus may, for instance, develop in a coal miner affected with carbon monoxide poisoning, the eyes responding to irritation or disease in the central nervous system. The great majority of cases of nystagmus among coal miners, however, is due to poor illumination or to faulty visual fixation of objects on the black coal face.

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*In annual convention at Rochester, New York, September 26, 1921.

Miners' nystagmus is the best known and the most thoroughly investigated example of occupational nystagmus; it occurs—according to various authorities—in from three to 25 per cent. of coal miners. It usually appears between the ages of 35 and 40 years among men who have engaged in mining for many years. Coal miners are much more prone to this affection than other underground workers. This fact is attributed by the Miners' Nystagmus Committee of the British Medical Research Council to the additional blackness from the coal face. Of all cases of nystagmus among underground workers investigated by this committee, 81.5 per cent. were found among miners who work at the coal face, that is, among those who actually drill, cut, or pick the coal. A large percentage of the persons affected by miners' nystagmus are undoubtedly predisposed to this disease through uncorrected errors of refraction. One reason for this is that many miners will not wear glasses because they cloud or "steam" easily underground. Nystagmus is rare in metal mines in which there is good illumination, and is much less frequent in coal mines with adequate illumination, whitewashing, and ventilation.

Treatment for nystagmus should begin with a discontinuance of work at the coal face or a complete change of occupation, where feasible. This should be followed by rest, correction of refractive errors, and general building up of the patient, both physically and mentally. Very few cases of nystagmus persist under such treatment. Usually all physical signs of the ailment leave within two years after the man has left coal face work. Many clear up within a much shorter time.

Preventive measures need to include the correction of refractive errors and muscular instability; adequate illumination, without glare, whitewashing of extensive portions of mine passageways and timbers; arrangement of working hours so that there may be opportunity for recreation in daylight; thorough medical supervision, and the maintenance of high physical standards among workers; and proper mine sanitation, particularly with reference to humidity, cooling power of air and absence of carbon monoxide.

Venereal Diseases

It is common knowledge that there is a great deal of venereal disease among certain classes of industrial workers; that this disease is spread by the common use of towels and drinking cups and by unsanitary toilet and washing facilities; and that venereal disease may very seriously affect the eyes. It is not necessary here to discuss the moral and economic obligation of industry to protect its workers against the possibility of contracting such disease within the place of employment. Nor is it necessary in this volume to discuss the means which may be employed in industry for the eradication of venereal diseases. Such information has been spread broadcast by the United States Public Health Service, the American Social Hygiene Association, the American Public Health Association, and the several other national organizations more directly interested in the cure and prevention of these diseases. It is intended, here, merely to emphasize the fact that every thoroughgoing effort to reduce the eye hazards of industrial occupations should include protection against the spreading of venereal disease.

Trachoma

Trachoma is the eye disease with which industry is seriously concerned because of its highly contagious nature. Trachoma, or true "granulated lids," begins with slight redness and discharge from the eyes. Even in this stage it is very easily carried from one person to another by means of towels, wash basins, and things which are commonly touched in public, such as railings, door-knobs, street car straps, etc. Once started it becomes a great danger to the eyesight because the eyelids turn in on the eyeball, the eye ulcerates, and the cornea or window of the eye becomes cloudy, affecting the vision.

At first there may be but little pain, only a feeling as though something were under the lid, scratching the eye. The eye waters and becomes red. If promptly and properly treated at this stage a complete cure is possible. But if neglected, it soon will so blind the patient that he can do no work and moreover he becomes a danger to other people. Ulceration follows and often causes total blindness, and then severe pain sometimes makes it necessary to remove the eye.

Although the incidence of trachoma is in the main concentrated in particular sections of the country, cases of the disease may be found in practically every community. Because of the communicable nature of the disease and because its seriousness is little appreciated by many classes of laboring people—being called merely "red sore eyes" by many of them—the existence of even a single case in any industrial community exposes that community to the danger of an epidemic of the disease. Following the outbreak of such an epidemic among steel workers and their families in Youngstown, Ohio, 242 cases of trachoma were discovered and treated within a period of four months, by the Youngstown Sheet & Tube Company. In a survey as late as 1920 of the prevalence of trachoma in southern Illinois, sixteen cases were found within two blocks in one mining town.

Many industrial companies, recognizing the highly communicable nature of trachoma, have long been on their guard against the disease. Their method was for many years—and undoubtedly still is today in some plants—to refuse employment to any applicant known to have trachoma and to discharge at the first opportunity any employe found to be a victim of the disease. Little effort was made either to cure or to prevent the spread of the disease, except by discharge of those afflicted. In many cases neither the employer nor the employe realized that the latter had trachoma until the disease was so far advanced that marked deterioration of the eye was apparent. Meanwhile the afflicted person may have infected dozens of other employes and the disease in his own case may have progressed to the point where a cure was doubtful or impossible.

The New Attitude of Industry

Within recent years, however, a new attitude toward trachoma and a new method of eliminating it from the ranks of industrial workers have been developed by those progressive employers who are giving serious attention to the health and safety of their employes. The policy and methods of the United States Steel Corporation in dealing with trachoma are characteristic of this new idea. Years ago the Steel Corporation, in common with practically all other employers, refused to consider for employment a workman recognized as a trachoma victim, and scores of men were turned away at the gate for this reason. But what happened to these men? This: they went from one steel plant to another, assumed aliases, learned in some cases to conceal the true condition of their eyes, and eventually found employment in one of the many plants of the corporation. In time the condition of their eyes would be discovered, they would be discharged, and would repeat the process. The technique of employing men was not then so highly developed as it is today. A steel worker with trachoma, and a persistent spirit, could within a period of a year work for three or four weeks in each of a dozen

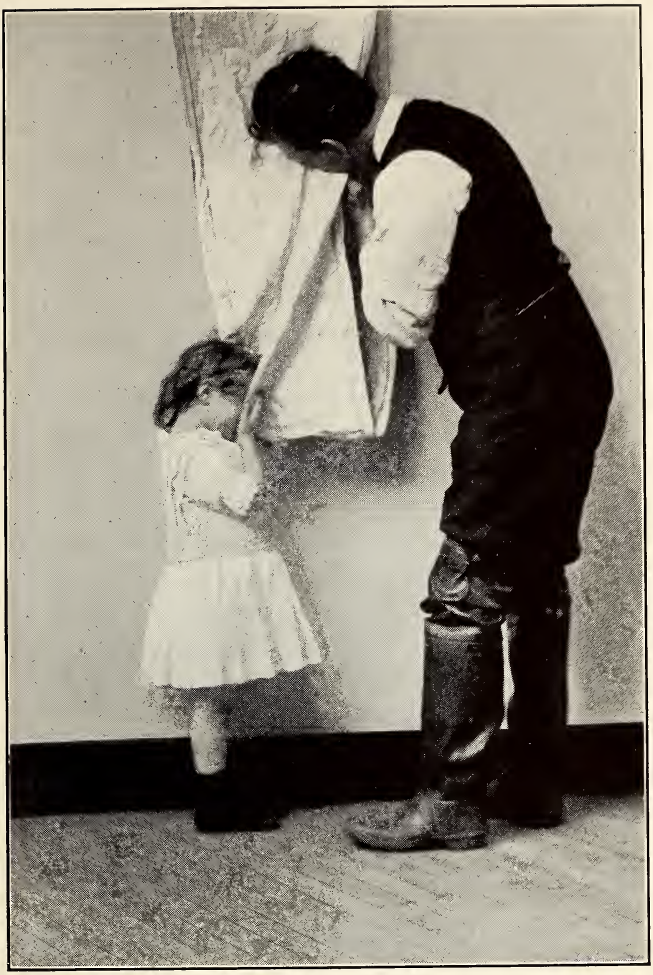

Figure 48.—The roller towel in industry, as well as in the home, has done more to spread trachoma and other contagious eye diseases than any other single force, and has been responsible for numerous epidemics of eye diseases in industrial plants.

steel plants, and at the end of that time start all over again making the rounds of the same plants.

This attempt to keep trachoma out of the plant defeated its own purpose. It did succeed in excluding many trachoma carriers from the steel plants, but those who were able by hook or crook to secure short-time employment in one plant after another exposed a greater number of fellow workmen to the disease than if they had been employed permanently in any one plant. And the attempt probably was more expensive than the more intelligent, humane and effective methods now used by the Steel Corporation to eradicate this disease. For hiring and firing has always cost more than sanitation, medication and education.

The policy of the United States Steel Corporation today—and this has been its policy for a number of years—is still to discover every case of trachoma among its employes and applicants for employment, but for another purpose, also, and that is to cure the disease in each individual case where that is possible. During the outbreak at Youngstown in 1914, the Steel & Tube Company treated every case of trachoma brought to its attention, women and children as well as men, irrespective of whether the father or husband was a steel worker.

Every employment manager and employment clerk in the subsidiary companies of the corporation has instructions for the detection of trachoma when hiring. Foremen, superintendents, and other supervisory officers are constantly on the alert for symptoms of trachoma among the men in their respective departments. Every paymaster makes it a part of the routine to glance at the eyes of each workman as he passes out the pay envelope to him, and to make a note of the check number of every workman who seems to have any trouble with his eyes. The paymaster each day reports to the medical department the check numbers of the men whose eyes seemed diseased, and on the following work day these men are instructed to report to the medical department for examination. Where trachoma is found, every possible effort to cure it is made by the medical department of the corporation.

Cleanliness the Best Preventive

The means that should be taken to prevent the spread of trachoma in any industrial plant are the ordinary means which should be taken to avert the spreading of any communicable disease. The first step in this direction should be the elimination of the common towel in any form and the provision of sufficient and thoroughly sanitary washing facilities. Although the old-fashioned roller towel has been legislated out of existence in most states, and although few employers deliberately provide roller towels for their employes, thousands of plants still tolerate the use of a common towel by a number of workmen. Many other plants, through their failure to provide even the most inexpensive individual paper towels and through their general neglect of health education, encourage the use of common towels. The writers have in recent years personally seen common towels in use in newspaper offices, printing plants, machine shops, general business offices and an endless variety of industrial plants.

Industry generally might well take its cue in this respect from the United States Steel Corporation which, above everything else, has a well-deserved reputation for good business judgment. The 1923 report of Charles L. Close, Manager of the Bureau of Safety, Sanitation and Welfare of the Steel Corporation, shows expenditures of more than $21,000,000, for sanitation in the plants of the corporation during the last ten years. The steel corporation has, during this period, spent more than twice as much for sanitation as for accident prevention, and the corporation is generally recognized to be doing the best safety work in America.

Adequate and modern washing facilities with plenty of soap and hot water available at all times is as essential as the use of individual towels. The importance of adequate, modern and well maintained toilet facilities cannot be over-emphasized. Because of the high potentiality of door knobs, flush valves and water faucet handles as spreaders of contagious disease, the use of labyrinth entrances and of intermittent automatic flushing systems or of foot pedal flushing systems instead of the common contact flush valves now in general use are recommended to employers who would take every possible means to avert the spread of contagious disease.

CHAPTER VIII

INDUSTRIAL LIGHTING

It is obvious that no person can do his work efficiently unless he can see what he is doing, clearly and comfortably; yet this fundamental principle of industrial hygiene and business efficiency is violated in thousands of factories and offices. As a result, the worker suffers from eye strain or from one or more of the many disorders which have their root in eye strain, and industry suffers from decreased production, increased spoilage and errors, increased personal injuries and compensation costs, and lowered plant morale.

The proper lighting of factories and other work places has always been important from the standpoint of conservation of vision and prevention of blindness, as well as from the purely economic point of view. It is, however, yearly becoming increasingly important, for these reasons:

> FIRST, the growth of industry in general and particularly the development of new types of machinery and its application to ever increasing numbers of processes increase continually the number of eye accident hazards to be guarded against. These hazards are decreased to a considerable extent by proper and sufficient illumination.
>
> SECOND, modern methods of mass production with their emphasis on speed often require continuous eye strain for hours. This eye strain continued over considerable periods of time results in a permanent impairment of vision with the inevitable consequences of increased accident hazard and deterioration of the quality of the product.

Third, the twenty-four-hour plant is becoming more and more common. This means that two out of three eight hour shifts must work most of the time with artificial lighting.

The Effects of Poor Lighting

The effects of poor illumination on production efficiency and on the accident experience of industrial plants are similar to the effects of defective vision described in an earlier chapter. For the vision of the best eyes in the world becomes defective where there is glare or insufficient illumination. The National Safety Council, for instance, reports that a careful analysis of 91,000 accidents showed that about 24 per cent., or more than 21,000, were due wholly or in part to poor lighting.

While most employers and employes are familiar with the dangers of accidental injury to the eye, many do not yet appreciate the harm that is done by poor lighting. Impairment of vision is usually a slow process, often going on for months or years before the individual becomes aware of it. Fatigue and eye strain, caused by improper lighting, whether due to insufficient candle power or too great intensity, lead to myopia (near-sightedness), then to a gradual decrease of vision, and possibly to total blindness. Only during recent years has lighting been taken out of the janitor-service class in the minds of most factory executives and placed where it belongs, in the class with automatic machinery, labor saving devices, and safety equipment.

Lighting Codes

It is not the purpose of this bulletin to give in great detail the technical specifications of good illumination but, rather, to point out its importance, especially from the standpoint of sight conservation. The technical requirements are given in detail in the American Standard Code of Lighting for Factories, Mills and Other Work Places.* This code is based upon three rules covering:

(a) the amount of illumination required;

(b) the avoidance of glare; diffusion and distribution of light;

(c) exit and emergency lighting.

The National Committee for the Prevention of Blindness is primarily concerned with the proper application of the first two of these rules because the resulting reduction of accidents would include its pro rata share of eye accidents and also because proper illumination reduces eye strain.

Survey of Lighting Conditions

While it is true that a scientific measurement of light and the determination of proper installations can finally be made only by the illuminating engineer, nevertheless in practice much of the illuminating equipment of our factories, mills and other work places is installed and maintained without such supervision.

The application of common sense will make it possible for any factory executive to discover for himself many of the faults of the lighting system in his plants, where such exist. A survey of the natural and artificial lighting of any place of work should take into account the following factors: arrangement of windows and skylights for maximum natural light; arrangement of desks, machines, and work benches so that employes do not face windows; avoidance of shadows, especially at the operating points of machines; selection of a lighting system and equipment requiring a minimum of local lights; illumination for out of the way corners where valves, switches, stairs, etc., are located; facilities for cleaning lights and reflectors with a minimum of inconvenience or accident hazard.

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* Prepared under the direction of and issued by the Illuminating Engineering Society, 29 West 39th Street, New York City.

It is possible for the layman to measure accurately the amount of illumination which exists in any given work conditions by the use of the foot-candle meter, a simple moderately priced instrument designed for practical use where a large photo-meter and trained operator are not available. The simple directions which accompany the instrument enable the operator with a little practice to measure foot-candles accurately enough for most practical purposes. In many cities a foot-candle meter may be borrowed for a day or two from the local gas or electric lighting company. It is wise policy in any industrial establishment of reasonable size to obtain one of these instruments and to train someone to check up at regular intervals on the actual efficiency of the lighting system in use in various workrooms.

Amount of Illumination Required

The amount of illumination necessary will of course vary with the processes in hand. The accompanying table, condensed from Tables I and II of the American Standard Code of Lighting Factories, Mills and Other Work Places, shows the intensities of light that are necessary under various conditions in industry:

	Recommended practice
(a) Roadways; yard thoroughfares	0.05 to 0.25 foot candles
(b) Storage spaces; aisles and passageways in workrooms excepting exits and passages leading thereto	1 to 2 foot candles
(c) Where discrimination of detail is not essential Spaces, such as:—hallways, stairways; exits, and passages leading thereto; toilet rooms; elevator cars and landings. Work, such as:—handling material of a coarse nature; grinding clay products; rough sorting; coal and ash handling; foundry charging.	2 to 5 foot candles

	Recommended practice
(d) Where slight discrimination of detail is essential Spaces, such as:—stairways, passageways and other locations where there are exposed moving machines, hot pipes, or live electrical parts. Work, such as:—rough machining, rough assembling; rough bench work; rough forging; grain milling.	2 to 5 foot candles
(e) Where moderate discrimination of detail is essential Work, such as:—machining; assembly work; bench work; fine core making in foundries; cigarette rolling.	5 to 10 foot candles
(f) Where close discrimination of detail is essential Work, such as:—fine lathe work; pattern making; tool making; weaving light colored silk or woolen textiles; office work; accounting; typewriting.	5 to 10 foot candles
(g) Where discrimination of minute detail is essential Work, such as:—watchmaking; engravings; drafting; sewing dark colored materials.	10 to 20 foot candles

Elimination of glare is assumed in all values given in this table. The foot-candle values apply, of course, to natural as well as to artificial lighting.

Natural Lighting

It would be fortunate for mankind if all work could be done under daylight illumination, the ideal light for the eyes.

Hence every effort should be made to use daylight and for as much of the time as possible. Experiments have shown time and again that good illumination increases production far beyond the cost of installation and this is just as true of natural as of artificial lighting. Fortunately the economic value of daylight has become so well known that practically all new buildings are constructed to utilize daylight as far as possible.

Sufficiency

Any lighting method, natural or artificial, must take into account three factors: sufficiency, continuity and diffusion. There must, first of all, be adequate window space. In general there are three ways in which window space can be provided—by side windows, by skylights and glass roofs, or by the saw-tooth roof construction. In the most modern plants these three means are combined and modified, according to local conditions, to secure the maximum amount of daylight. Some authorities say that the window area should be at least 10 per cent. of the floor area served, 20 to 30 per cent. being generally considered more desirable. Modern practice, however, tends to enlarge the amount of window space to the maximum consistent with the supporting strength of the walls.

Continuity

Even in the plant which is so constructed as to use daylight to the fullest possible extent for all of the time it is available during working hours, there are two conditions which make necessary the installation of an adequate system of artificial illumination: first, the short period of daylight during the winter months, especially in our northern latitudes; second, the cloudy and stormy days which cut down natural light to such an extent that work cannot be carried on without eye strain.

A condition which must be guarded against in using daylight, especially from any but a northern exposure, is excessive illumination due to direct sunshine. Where this condition exists, means must be provided for cutting down the amount of light by the use of ribbed glass or translucent shades. In general, it is advisable to have shades which may be raised from the bottom of the window. This makes it possible to provide sufficient illumination for the interior of the room and, at the same time, remove the objectionable direct sunlight from the plane of vision of workmen located near the windows. It is better still to have shades which may be adjusted from the top or bottom.

Adjustment of window shades or other devices should not be left to those workers who may be nearest the windows, but should be controlled by the room foreman. He should readjust the window equipment for the varying daylight conditions and he should decide also when artificial light should be used to make up for a deficiency in daylight in any location.

Maintenance of Natural Lighting

If sufficiency, adequacy and diffusion are to be maintained, clean windows must be the rule. Clean windows will go far towards solving the lighting problem in many plants. Wherever possible, windows should be cleaned at least once weekly. In a number of plants which are equipped with an abundance of window space it has been found that the accumulated dust, grease and grime on the window panes cut down the natural illumination almost to zero—so much so in fact, that it is necessary during practically all the working hours of the day to resort to artificial light.

The fact that light is a tool which increases the efficiency and safety of every other tool is fully appreciated by the Ford Motor Company which spends approximately $2,000,000 a year to keep its plants clean, a large portion of which sum is for the washing of windows. An all day tramp through the Highland Park plant of the Ford Company failed to disclose a single window badly in need of a wash. Every window in the plant is clean, every wall painted white, every windowless spot adequately supplied with artificial light. Every glass roof—and it seems that there are miles of them—is equipped with rails for an especially constructed window washing truck.

Another example of the importance that is placed on clean windows by progressive industries is in one of the new plants of the National Tube Company at McKeesport, Pa., where $50,000 was spent for the construction of a window washers' railway system immediately under the glass roof of the plant to facilitate the washing of windows and electric lamps.

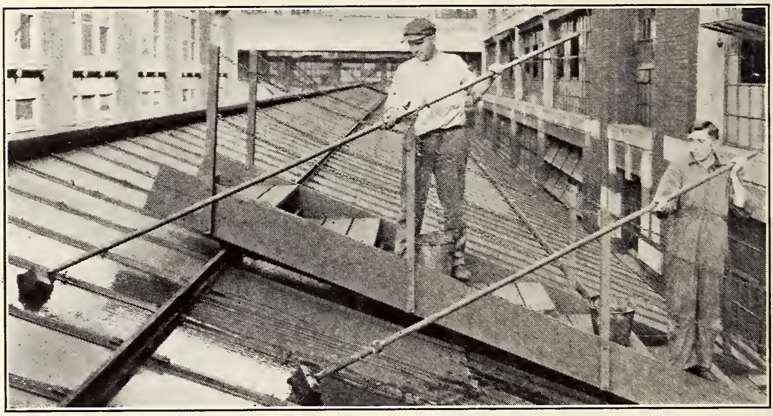

Figure 49.—Henry Ford knows the value of good lighting as a means of reducing accidents and eye strain and increasing production; that is why he spends tens of thousands of dollars yearly merely for the washing of windows and skylights in his plants.

To secure a proper diffusion of light, attention must be given, also, to the interior decorations of the working place. These should, in general, be as light in color as practicable for ceilings and the upper portions of walls, and should have a dull finish. The nature of many industries is such that the interior decoration should be cleaned or renewed at frequent intervals. Dirt and smoke can soon decrease the illumination not only through deposits on windows but likewise on ceilings and walls.

Glare

Glare has been defined as any brightness within the field of vision of such a character as to cause discomfort, annoyance, interference with vision, or eye fatigue. It is one of the principal causes of eye strain and is, therefore, always to be avoided, yet it is one of the most common defects of lighting systems. The scientific measurement of glare must be left to the illuminating engineer and to the physicist. It is possible, however, for the layman to recognize most of the conditions which cause glare. The causes and effects of glare are clearly defined in the notes on Rule 2 in the American Standard Code, of which the rest of this chapter is an abstract.

Glare is objectionable because (1) when continued, it tends to injure the eye and to disturb the nervous system; (2) it causes discomfort and fatigue and thus reduces the efficiency of the worker; (3) it interferes with clear vision, and thus increases the risk of accidental injury to the worker. From both a humanitarian and a business point of view, the owner or operator of a factory should seek to avoid glare, whether caused by daylight or by artificial light. If a simple instrument were available for measuring glare the task would be comparatively easy. However, there are so many factors entering into the situation that it has not been found practicable to develop any instrument which will properly evaluate them all. To arrive at an intelligent judgment in any given case, the principal causes of glare should be considered.

Causes of Glare

There are five principal causes of glare:

Brightness of Source—The light source may be too bright; that is, it may give off too high a candle-power per square inch of area. A glance at the sun proves that an extremely bright light source within the field of vision is capable of producing acute discomfort. Light sources of far lower brightness than the sun, such, for example, as the filament of an incandescent electric lamp or the incandescent mantle of a gas lamp, may also cause discomfort, although the annoying effect is usually not quite so marked.

Total Volume of Light—The light source may be too powerful for comfort; that is, it may give off too great a total candle-power in the direction of the eye. Too frequently glare is assumed to be entirely a question of the brightness of the light source; of equal importance is the question of its total candle-power. Experience has shown that a 500-watt lamp in a 10-inch opal globe, or a mercury-vapor lamp of an equivalent light output, hung 7 or 8 feet above the floor and a similar distance ahead of the observer will prove quite as glaring as the exposed filament of a 50-watt incandescent

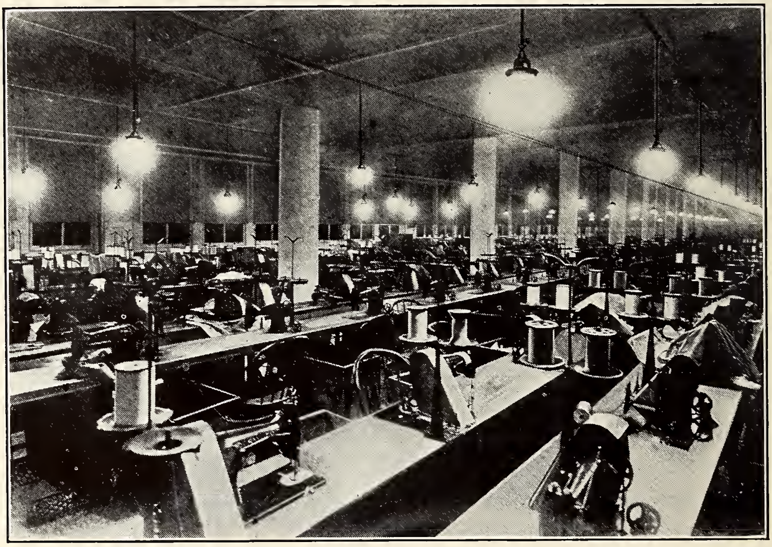

Figure 50.—A typical installation of satisfactory gas lighting for sewing machine operatives.

lamp in the same location. The brightness of the opal globe unit is only a few times that of a candle flame, but its total candle-power, and consequently the quantity of light which reaches the eye, is altogether too great, so that its effect is worse than that of the bare filament of lower candle-power, although the latter may have a brightness as high as 300 candle-power per square inch. An unshaded window often causes glare due, of course, to the large volume of light rather than to the high brightness of the sky.

Location in the Field of View—A given light source may be located at too short a distance from the eye, or it may lie too near the center of the field of vision, for comfort; that is, within too small an angle from the ordinary line of sight. The 500-watt opal globe unit discussed in the previous illustration would seldom cause discomfort if placed, say, 80 feet away from the observer, for at this distance the total quantity of light entering the eye would be only one-hundredth of that received at 8 feet. Again, the same light source would probably be found quite unobjectionable at a distance of 8 feet from the eye provided this distance was obtained by locating the lamp 4 feet ahead of the observer and 7 feet above the eye level; in this case the lamp would scarcely be within the ordinary field of view.

The natural position of the eye during intervals of rest from any kind of work is generally in the horizontal direction, and it is desirable that during such periods the worker should be freed from the annoyance caused by glare. Glare is the more objectionable the more nearly the light source approaches the direct line of sight. While at work the eye is usually directed either horizontally or at an angle below the horizontal. Glaring objects at or below the horizontal should especially be prohibited. The best way to remove light sources out of the direct line of vision is to locate them well up toward the ceiling. Local lamps, that is, lamps placed close to the work, if used at all, must be particularly well screened.

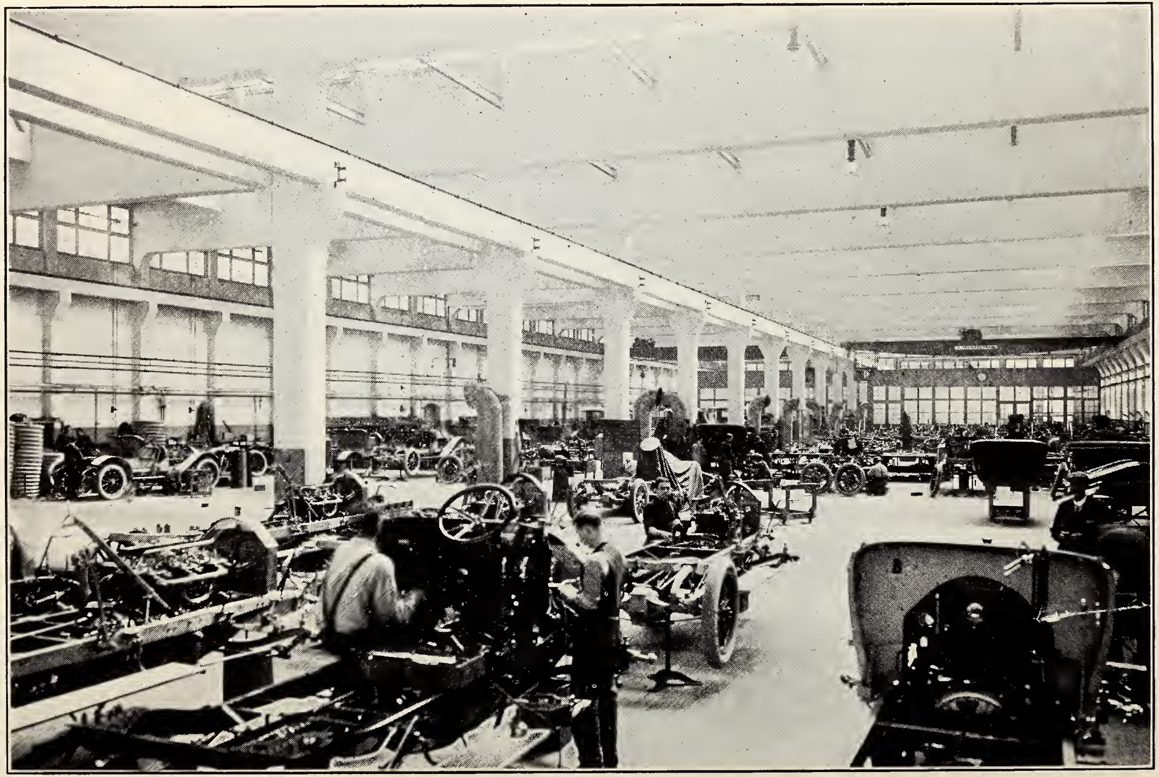

Figure 51.—Interior view of assembly room of Pierce-Arrow Motor Car Company, Buffalo, N. Y., showing daylight illumination secured by physical construction of plant, as illustrated in Figure 52.

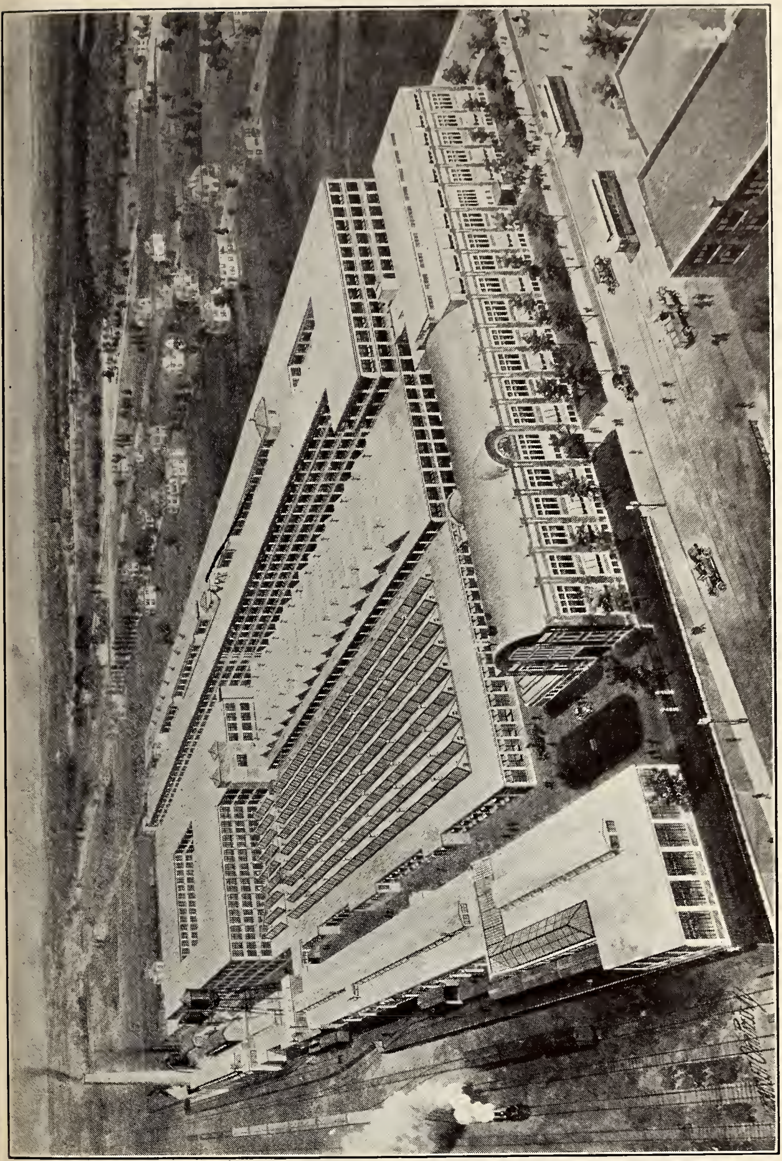

Figure 52.—Plant of the Pierce-Arrow Motor Car Company, Buffalo, N. Y. Great window area, saw-tooth and monitor roof construction make for the utmost use of natural light.

Contrast with Background—The contrast may be too great between the light source and its darker surroundings. It is a common experience that a lamp viewed against a dark wall is far more trying to the eyes than when its surroundings appear relatively light. A light background requires, first: that the surface should be painted in a color which will reflect a considerable portion of the light which strikes it, and second: that the system of illumination employed should be such as to direct some light upon the background. In many cases the ceiling appears almost black under artificial light simply because no light reaches it. With daylight, on the other hand, the walls of a room are often so well illuminated that they appear brighter than the work itself and this, also, is a condition which is not conducive to good vision. In

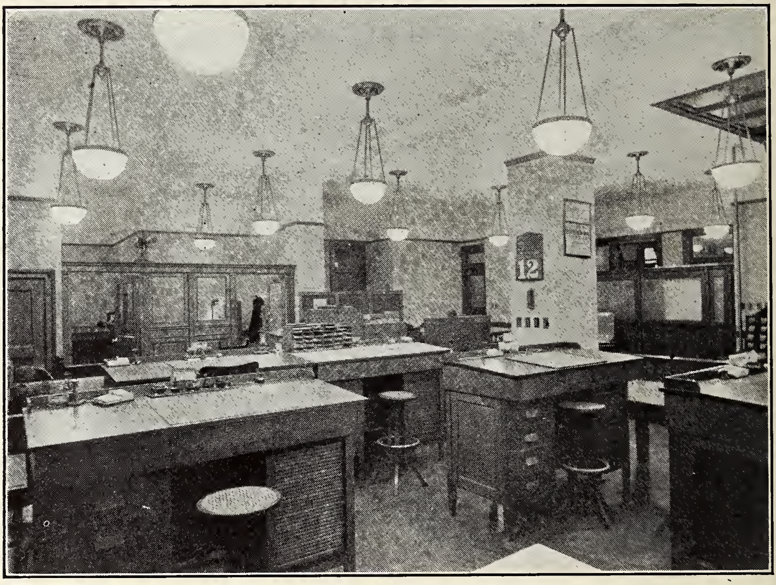

Figure 53.—Semi-indirect office gas lighting. Note the absence of shadows even on the ceiling.

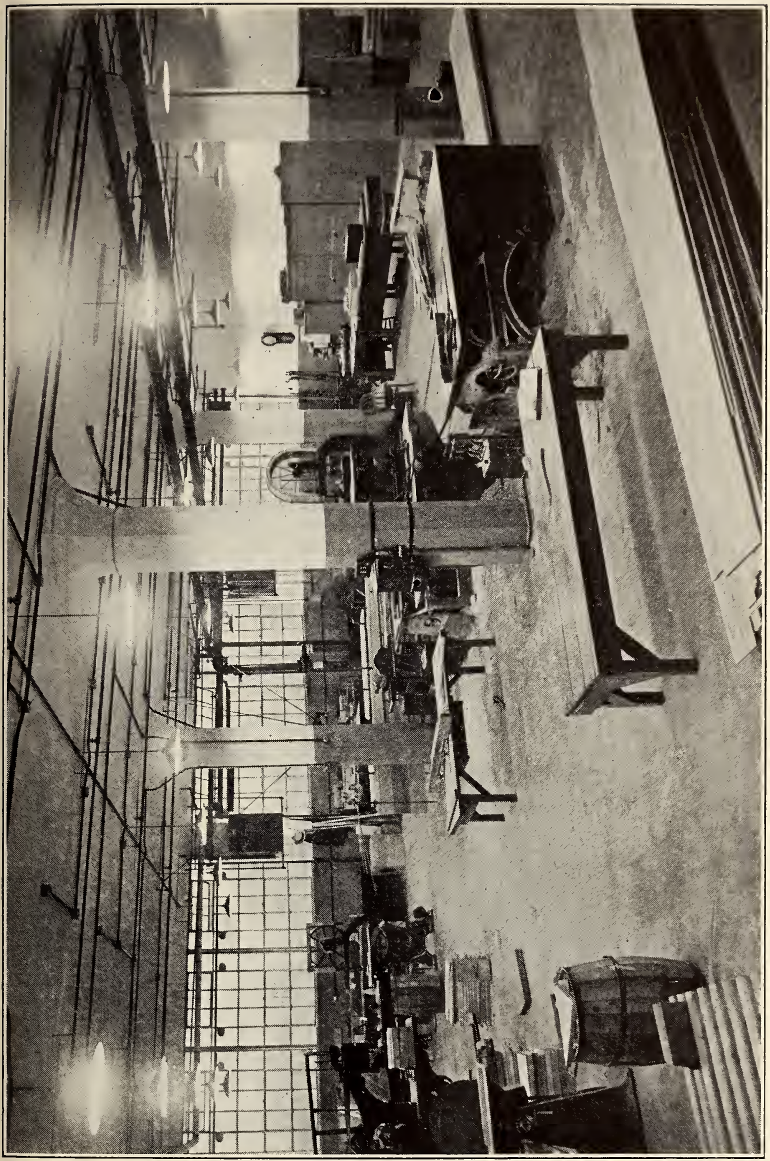

Figure 54.—An excellent example of a modern lighting installation in a woodworking shop.

general, a light tone for ceilings and high side walls and a paint of medium reflecting power for the lower side walls will ordinarily be found most satisfactory under both artificial and natural lighting.

Where strictly local lighting systems are employed, that is, where individual lamps are supplied for all benches and machines, and no overhead lighting is added, the resulting contrasts in illumination will usually be found so harsh as to be objectionable even though the lamps themselves are well shielded. The eyes of the workman looking up from his brightly lighted machine or bench are not adapted for vision at low illuminations hence, if adjacent objects and aisles are only dimly lighted, he will be compelled either to grope about, losing time and risking accident, or to wait until his eyes have become adapted to the low illumination. Glancing back at his work, he again loses time while his eyes adjust themselves to the increased amount of light which reaches them. If long continued, this condition leads to fatigue, as well as to interference with vision and to accidents. In other words, where local lamps are employed, there should also be a system of overhead lighting which will provide a sufficient illumination of all surrounding areas to avoid sharp contrasts.

Time of Exposure—The time of exposure may be too great, that is, the eye may be subjected to the strain caused by a light source of given strength within the field of vision for too long a time. Where an operator is seated and his field of vision is fixed for several hours at a time, light sources of lower brightness and lower candle-power are required than where the operator stands at his work and shifts his position and direction of view from time to time. In the first case the image of the light source is focused on one part of the retina for considerable periods of time and is obviously more likely to cause discomfort and eye strain than when present for short periods only. Those who are forced to work all day at desks facing the windows are particularly likely to suffer from this form of glare.

CHAPTER IX

EDUCATION AS TO SAFETY

The greatest possibilities for the elimination of the unnecessary eye hazards of industrial occupations lie in education—education of the state as to its moral and economic obligations; education of the employer as to the desirability, from his own point of view, of supplying adequate protection for the eyes of his employes; and education of the employe, particularly the old-fashioned and so-called hard boiled employe, as to the necessity of using that protection when it is provided. Consideration of these three groups will be taken up separately.

Education of the State

While it is patent that safety cannot be legislated into an industrial plant—certainly not into an entire state—nevertheless it is futile to expect certain types of employers to give serious attention to the prevention of accidents, to the provision of proper lighting facilities, and to sanitation within their property if the state itself gives little attention to these matters. Some states do not yet require even the reporting of industrial accidents. Others require such reports, but make no effort to set up safety standards of lighting and sanitation codes for the guidance or observance of their industries notwithstanding the fact that it is now a simple matter for any state to obtain from the more progressive industrial states, from national trade associations and technical societies, from the United States Bureau of Standards, or from the American Engineering Standards Committee* drafts of safety codes prepared by experts representing all interested parties and approved as national standards.

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* 29 West 39th Street, New York City.

The state's opportunities in this direction will not be fulfilled until legislators and administrative officials of every state recognize that the prevention of accidents is a moral and economic obligation of the state as well as of the individual employer. The state machinery best suited for the formulation and the administration of industrial safety regulations appears to be an industrial commission with full power to make and administer rules which may be varied from time to time to conform to changes in industrial conditions, rather than a code of laws which can be changed only by a legislature which meets once in two years and which is often influenced by political expediency.

The most progressive states do not stop with the administration of fair and intelligent safety regulations; they render various forms of accident prevention service to their industries, and they encourage the individual employer and employe to give serious attention to the prevention of accidents by providing, in their workmen's compensation laws penalties for neglect of safety and credits or some other form of commendatory rating for efficient safety work. In Wisconsin, for instance, in the event of accidental injury to the eye of a workman the employer is penalized 15 per cent. in addition to the prescribed amount of compensation if it is shown that he failed to provide goggles or to instruct the workman to wear them; if, on the other hand, it is shown that protection had been provided for the workman and that he had been instructed in the use of the protective devices, but had neglected to take advantage of this protection, he is penalized 15 per cent. of the compensation that he would ordinarily have received.

Education of the Employer

Many employers of labor still need to be convinced that it is cheaper to prevent eye accidents than to pay for them;

that it is false economy to use cheap goggles or to have a group of workmen share one pair of goggles; that the wearing of goggles or other head protection in dangerous operations should be made an absolute condition of employment. Fortunately, it is no longer necessary to resort to theoretical or academic arguments to convince the individual employer, for there are available records of the experience of numerous companies, statements of foremen, superintendents, managers, and plant owners, and any amount of authentic statistics to bear out each of these assertions.

The owner or manager of an industrial property is naturally concerned primarily with the production of his commodity at the lowest possible cost consistent with the standard of quality that he has set out to maintain. Except in the comparatively few industrial properties where safety has become a definite part of the general manufacturing process, the prevention of accidents and the protection of the health of workers are considered of secondary importance.

The situation was most aptly described by C. P. Tolman when, as president of the National Safety Council, he said:

> "Usually the engineer is required to make the plant as safe as possible with the following stipulations: he must not interrupt operations; he must do nothing which would decrease output or increase cost; he must not make changes of a character or in a manner to cause labor trouble; he must not make changes which will affect the character of the product; otherwise he has a free rein. This seems to leave little chance for accomplishments. But hundreds of engineers are doing effective safety work under just such restrictions."

The result of this situation is that for every plant doing effective safety work a hundred are shirking their responsibility. Indeed few employers are giving as serious attention to accidents—their cost, the possibility of preventing them, and the profits which can be made through such preventive work—as to the cost of labor, raw materials, and other items in the manufacturing process.

Cheaper to Prevent Accidents than to Pay for Them

The report growing out of the survey of waste in industry, which was conducted by the Federated American Engineering Societies under the direction of Herbert Hoover, shows an estimated loss of 158,000,000 work days as the result of non-fatal accidents occurring in industry in one year. On the extremely conservative estimate of $1.50 a day as the average compensation paid to workmen for time lost due to accidents, there is a loss to employers of $237,000,000 a year as the result of non-fatal accidents alone. It is conservatively estimated, also, that eye accidents constitute 10 per cent. of all non-fatal industrial accidents. On the basis of these estimates it appears that the loss to industry through eye accidents is in excess of $23,000,000 yearly. No employer or industrial manager who is aware of these facts will question the assertion that it is cheaper to prevent eye accidents than to pay for them.

The statements of several industrial executives telling the experiences of their own companies in this regard may be more to the point. In a letter to the National Committee for the Prevention of Blindness, G. A. Kuechenmeister, Personnel Manager of the Dominion Forge and Stamping Company, says: "Several years ago we lost $3,200 through one eye accident. Since then we have supplied goggles gratis to every man engaged in work where there is a hazard to the eye and we haven't spent $500 for goggles yet.

Dr. V. E. Van Kirk, industrial physician for a steel company in the Pittsburgh district, in a paper read before the Ophthalmology Section of the American Medical Association,* says: "In twenty or twenty-five cases a year it is found that the vision of one or both eyes has been saved by the use of goggles. This alone saves the company about $50,000 or $60,000 in compensation."

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* 73d Annual Meeting, St. Louis, Mo., May, 1922.

During 1922 the American Car and Foundry Company spent approximately $10,000 for goggles and other eye protective equipment. The Pennsylvania Railroad, the Ford Motor Company, The Pullman Company, the United States Steel Corporation and other industrial concerns with reputations for keen business judgment have spent proportionately large sums for the protection of the eyes of their workers. These companies would not have spent such amounts for eye protection and would not continue to do so year after year if they were not convinced by actual experience in their own plants that it is cheaper to prevent eye accidents than to pay for them.

False Economy to Use Cheap Goggles or to Permit Workmen to Share Goggles

The false economy of cheap mechanical guards and safety devices is a matter of common knowledge among professional safety men. Nowhere is this more true than in the case of goggles and other forms of eye protection. Practically all excuses offered by workmen for failure to wear goggles come under one of the following heads: discomfort, obstruction of vision, and (surprising as this may seem in view of the greater danger of working without goggles) fear that if the lens is broken fragments of glass will enter the eye. Cheap goggles multiply the opportunities for such excuses and often provide justification for them with the result that the workmen develop prejudices against all goggles and it is later difficult to persuade them to wear conscientiously even the most expensive goggles.

Notwithstanding these facts, there are still hundreds of plants where the selection of goggles is determined by their price rather than their suitability for the work in hand or the adequacy of the protection they afford. In hundreds of other plants men and women engaged in occupations requiring eye protection are permitted or instructed to purchase their own goggles. Many of these go to ten cent stores, small notion stores, or street peddlers and buy the cheapest goggles they can get. It is unnecessary here to elaborate on the possibilities of headaches, gradual impairment of vision, shattering of lenses, and other dangers incidental to such procedure.

In still other plants goggles are provided of suitable type and quality, but not in sufficient numbers. The cigar box containing one pair of goggles for the use of an entire department is still a common sight in many plants. Often not even a box is provided; the goggles hang on a nail above the emery wheel. Workmen who are willing to use this community pair of goggles must go to the trouble of cleaning them each time they have occasion to use the emery wheel. More often they use the grimy or dust-covered goggles without a pretense of cleaning; the accidents and spoilage which follow cost the company far more than it would to provide a pair of the best goggles for every employe. Whether or not the workmen who use community goggles make any effort to clean them, they are exposed to any communicable eye disease from which any of the users is suffering. Realizing this, many workmen avoid the one common pair of goggles, and sooner or later the owner of this plant pays as compensation for an eye injury several times what it would have cost to give every worker a pair of goggles for his own use.

Usually where any one of these three conditions exists—the provision of low quality goggles; permission or instruction to employes to buy their own goggles outside of the plant; or the provision of one pair of goggles for a number of workers—it exists only because the purchasing agent or the plant manager is not in sympathy with safety work or has not been made to appreciate the fact that expenditures for accident prevention are not expenses, but investments which nearly always pay higher dividends than investments in any other branch of the business. In such cases the first and most important job of the safety engineer is to educate "the big boss" so that he will let it be known throughout his organization that protection of the worker and not immediate economy must determine the purchase of safety equipment.

Methods of Supplying Goggles to Employes

The basis on which goggles are to be supplied to employes can best be determined by the individual employer—the wage scale, the temperament of employes, and other local plant conditions being taken into consideration. One purpose, however, should be the aim of whatever plan is decided upon, and that is, to insure the maximum probability of the goggles being accepted cheerfully and worn conscientiously. The best goggles in the world are useless when carried in the pocket or worn on the forehead or cap.

In many plants where thorough-going safety work is being done, goggles are provided without cost to every workman as long as he is in the employ of the company and he is required to sign a receipt. This is probably the best plan, and the one in most general use. The formality of signing a card which is a receipt, a pledge to use the goggles, and an authorization to the company to deduct a dollar from his pay in the event of his failure to return the goggles on leaving the company has a salutary effect on the average workman. The reverse of this effect, however, usually results from any effort to inject into the receipt for goggles a disclaimer of liability for injury to the eyes while the goggles are not being worn.

On the theory that people appreciate most what they have to pay for, some plants require workmen in need of goggles to pay for them in whole or part. This theory, of course, is true in the case of certain types of workmen, but when put into practice is contrary to the spirit in which the most successful safety work has been done. In any circumstance, however, the employe should not be required to pay more than half the actual cost of goggles.

Proper Maintenance of Goggles

Fully as important as the proper provision of goggles is the provision of facilities for prompt adjusting, repairing, and replacing of goggles and lenses. The frames of goggles worn every day get out of shape; nose pieces often must be adjusted several times before the workman is satisfied; and lenses break, both in and out of service. Unless the workman whose goggles need adjusting or repairing is able to secure such service promptly there is great danger of his working under hazardous conditions without eye protection. Hundreds of eyes have been lost through just such momentary chance taking.

In many of the larger plants a central goggles distributing and service station is maintained, and one man is assigned to give his full time to this work. In smaller plants this function is assumed by the safety engineer or one of his assistants.

While the use of a single pair of goggles by a number of men is not to be condoned under any circumstances, it is recommended that where it is impossible to get away from this practice provision be made for easy sterilization of the goggles. This may be done by dipping them into a solution of three teaspoonfuls of formaldehyde (40 per cent.) to a quart of water. They should subsequently be dipped in sterile water, which can easily be obtained from the condensed steam from the boiler in a factory, otherwise the sweat will carry the formaldehyde into the eyes and cause much irritation.

Wearing of Goggles a Condition of Employment

One reason that the safety movement has not been more successful in industry—not overlooking, however, the fact that in many plants accidents have been reduced as much as 50 per cent.—is the very common practice of employers of announcing rules and penalties and then failing to enforce them. A common sight even in otherwise well-regulated plants is a man without goggles working at an emery wheel over which is a large dust-covered sign reading: "Any Employe Using This Wheel Without Wearing Goggles Will Be Discharged Instantly."

There are two schools of thought on the question of whether the wearing of goggles in certain occupations should be made an absolute condition of employment. One group thinks that this should not be attempted because it cannot be done—certainly not without greatly increasing the labor turnover, a matter which is likely to intensify opposition to all safety work on the part of production managers. Another group takes the stand that a large class of workmen are not susceptible to reason, education, or persuasion, and can be counted on to wear goggles conscientiously only if they are made to understand that loss of the job will be the penalty imposed for failure to wear them.

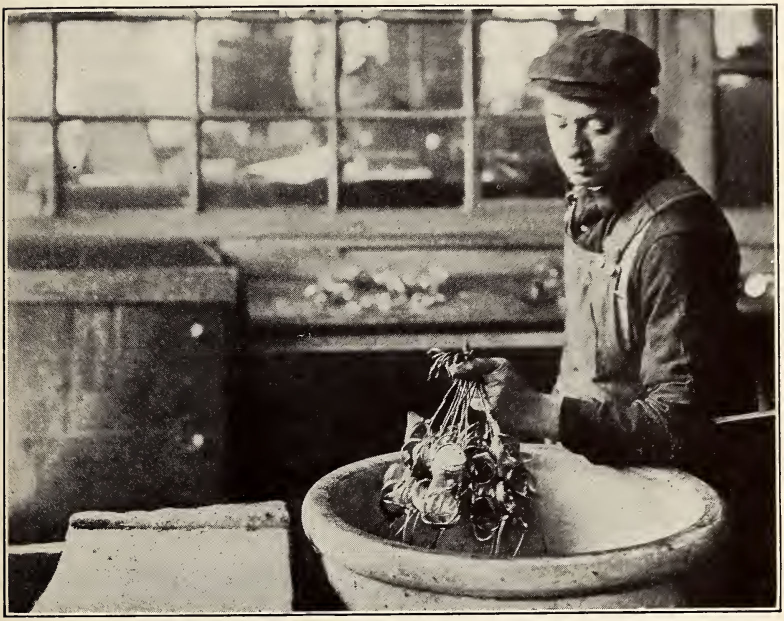
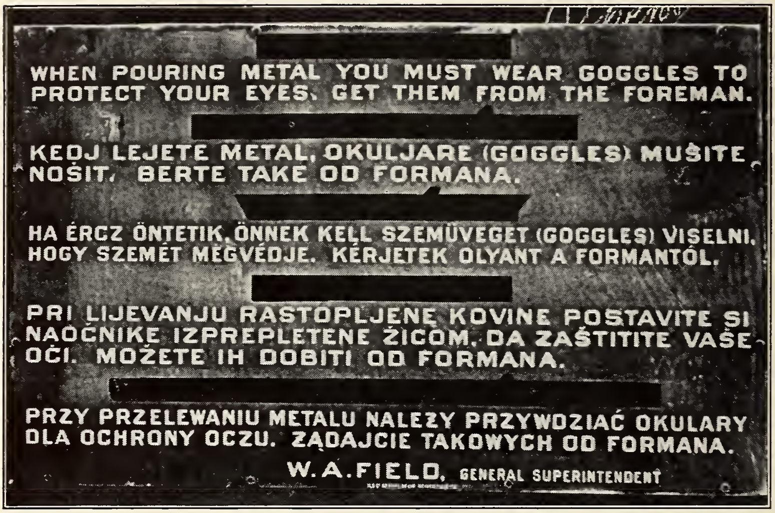


Figure 55.—Goggles may be sterilized by dipping in boiling water or a formaldehyde solution.

Whether or not the wearing of goggles should be made a condition of employment depends entirely on the situation in the individual plant, particularly on the extent to which real discipline exists in the plant. Each employer must settle this question for himself, but before doing so he should look the situation in his plant frankly in the face and should base his decision entirely on his ability and intention to enforce whatever rules and penalties are announced.



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WHEN POURING METAL YOU MUST WEAR GOGGLES TO PROTECT YOUR EYES. GET THEM FROM THE FOREMAN.

[redacted]

KEDJ LEJETE METAL, OKULJARE (GOGGLES) MUŠITE NOŠIT. BERTE TAKE OD FORMANA.

[redacted]

HA ÉRCZ ÖNTETIK, ÖNNEK KELL SZEMÜVEGET (GOGGLES) VISELNI, HOGY SZEMÉT MEGVÉDJE. KÉRJETEK OLYANT A FORMANTÓL.

[redacted]

PRI LIJEVANJU RASTOPLJENE KOVINE POSTAVITE SI NAOČNIKE IZPREPLETENE ŽICOM, DA ZAŠTITITE VAŠE OČI. MOŽETE IH DOBITI OD FORMANA.

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PRZY PRZELEWANIU METALU NALEŻY PRZYWDZIAĆ OKULARY DLA OCHRONY OCZU. ŻĄDAJCIE TAKOWYCH OD FORMANA.

W. A. FIELD, GENERAL SUPERINTENDENT

Figure 56.—Failure to understand English has cost many workmen their sight and many employers thousands of dollars in compensation. The progressive employer who has foreign labor posts his warnings in the languages of all his workmen, and at the same time does what is possible to teach them English.

Any number of safety engineers and industrial executives would state without qualifications that the goggle wearing rule is strictly enforced in their plants; that when a man refuses to wear goggles in hazardous work he is discharged. But, with few exceptions, the reports of eye injuries in these same plants nearly always carry the statement: "Was not wearing goggles as instructed." On the other hand, many of the most successful safety engineers, men who are in charge of accident prevention work in some of the most important and most progressive industrial properties in the world, say frankly that it is impossible to compel men to wear goggles; that persuasion and education are far more effective than any rule, no matter how stringently enforced, in inducing workmen to use goggles and other protective equipment. In these plants it has been found effective occasionally to make an example of a notorious scoffer of goggles by discharge, demotion, or temporary layoff. Such penalties, if judiciously imposed, are far more effective than any widely advertised but seldom enforced rule threatening instant dismissal for failure to wear goggles.

Education of the Employe

In the case of the employe—particularly the older employe—it is necessary to overcome the resistance against goggle wearing resulting from many years of working without such protection; it is necessary to overcome, in many cases, false pride and the belief that the wearing of goggles is an indication of cowardice or of approaching old age; it is necessary, most of all, to overcome the reluctance to try something new. The effort in this direction is necessarily divided into two phases: first, a year-round campaign for the prevention of eye accidents extending through the entire plant, and, second, special efforts to sell the goggle idea to the hard-boiled, prejudiced, or old-fashioned workman. Here also it is no longer necessary to experiment, for there is available the experience of scores of industrial plants and of individual safety engineers who have given a great deal of study to the subject and who have had exceptional success in this particular type of accident prevention work.

The value of special intensive drives such as Safety Weeks or Months as a means of convincing skeptics that it is possible to prevent accidents and of attracting widespread attention to the inauguration of a permanent safety campaign has been demonstrated repeatedly, both in industry and in public safety efforts. Any plant having a serious eye accident hazard can do nothing better to initiate, revive, or strengthen its activities in this direction than to conduct a short intensive eye protection campaign. Such a campaign may cover a period of a week, a month, or more. It should be followed by well organized, less spectacular activities the year round. The following procedure is suggested as a basis for a short intensive drive:

First, explain the plan and purpose of the campaign and arouse interest and competitive spirit through articles in the plant publication, announcements on bulletin boards, and noon-hour rallies;

Second, check up the various jobs to find just where goggles are necessary—where no other form of protection will be adequate;

Third, examine the goggles worn by each employe to determine whether they fit him properly and whether they give adequate protection;

Fourth, as fast as possible, locate employes who are encountering difficulties in wearing goggles, and investigate each case promptly and carefully, giving attention to the condition of the employe's eyes;

At the same time, an educational campaign should be carried on. This might include a series of meetings for foremen, departmental safety meetings, and mass meetings of employes. At these meetings there should be frank discussion of the plant's eye accident record, of the eye hazards to which employes are exposed, and of the company's future policy in the matter. The latter should come from the highest supervisory officer in the organization. Goggles which have been broken in service should be exhibited where all employes may see them, together with descriptions of the accidents and statements by the workmen wearing the goggles when they were damaged.

Illustrated safety posters showing the right and wrong way of doing certain work, injuries resulting from failure to use head and eye protection, and photographs of employes whose eyes have been saved by goggles should be used extensively during such a campaign. Scores of bulletins on the subject of eye protection have been issued by the National Safety Council, by various insurance companies, and by other agencies. These bulletins should be interspersed with home made safety bulletins such as those shown in Figures 57 and 58.

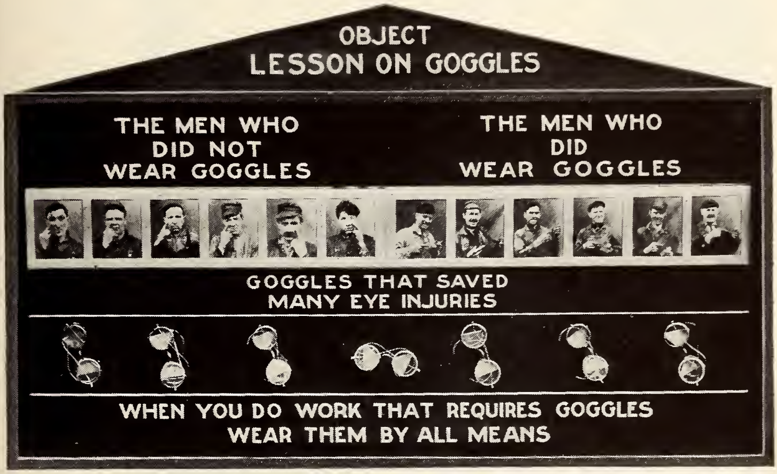
OBJECT
LESSON ON GOGGLES
THE MEN WHO DID NOT WEAR GOGGLES
THE MEN WHO DID WEAR GOGGLES
GOGGLES THAT SAVED MANY EYE INJURIES
WHEN YOU DO WORK THAT REQUIRES GOGGLES WEAR THEM BY ALL MEANS

Figure 57.—A good example of a safety exhibit which may be prepared easily in any plant.

The close of a special campaign against eye accidents is a good occasion for the issuance of an order requiring the wearing of goggles at every job where eye protection is needed, and these jobs should be specified. After a well-planned campaign of education such an order will be favorably received. In some organizations after the posting of such an order workmen have been heard to say "It should

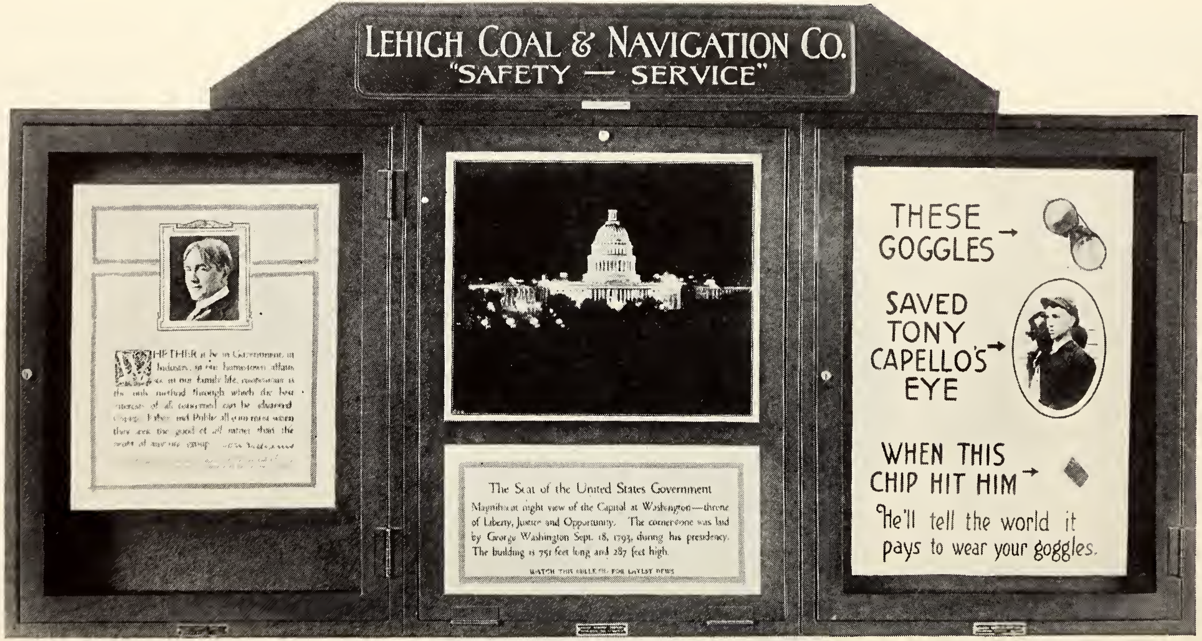
LEHIGH COAL & NAVIGATION CO.
"SAFETY — SERVICE"
The Seat of the United States Government
Magnificent night view of the Capitol at Washington—throne of Liberty, Justice and Opportunity. The cornerstone was laid by George Washington Sept. 18, 1793, during his presidency. The building is 751 feet long and 287 feet high.
WATCH THIS BULLETIN FOR LATEST NEWS
THESE GOGGLES →
SAVED TONY CAPELLO'S EYE →
WHEN THIS CHIP HIT HIM →
He'll tell the world it pays to wear your goggles.

Figure 58.—The ideal safety bulletin board for industrial plants—a news photo in the center to draw the workman to the board, an inspirational message from a big business executive on the left, and a simple but convincing home made safety bulletin on the right.

Courtesy Elliott Service Company

have been done long ago. Now we are getting down to brass tacks."

Among the year round activities which contribute toward a reduction of eye injuries are:

Physical examination of applicants for employment and periodic re-examination of employes.
Proper introduction of the new employe to his job, his foreman and fellow workers (the eyes of many workmen have been lost through failure to understand the work, through not knowing where to get a certain tool and reluctance to ask a stranger).
The organization of safety committees and special instruction for members of these committees.
Inter-departmental and inter-plant safety contests with the granting of prizes for unusual safety records.
The preparation of safety rule books for employes and foremen and drawings and specifications for standard equipment.
Safety lectures, exhibits, moving pictures, museums and "bad tool morgues"; safety suggestion systems.
Safety departments in plant publications.
Foremen's training courses.
Pay envelope inserts of slogans and sermonettes.
Periodic plant inspection for safe physical conditions and safe practices.
Warning signs and lights.
Language instruction (failure to understand instructions or to read warning signs printed in English is frequently the cause of serious accidental injury to foreign workmen).
Studies for the elimination of fatigue. These activities are listed without regard to logical sequence or relative importance, but merely as an indication of the broad character of a thoroughgoing safety campaign.

Getting the Stubborn Workman to Wear Goggles

A recounting of the special activities and novel methods which have been used successfully to induce stubborn employes to wear goggles would in itself fill a volume. The following experiences are typical.

In one plant a foreman came to the safety engineer and in a friendly way said very frankly that he could not wear goggles. He had honestly tried to do so, but they were simply driving him crazy, he said. The safety engineer without further questioning asked him if he knew a good oculist. The man named one, and arrangements were made at once to have his eyes examined. Within a few hours the oculist reported to the safety engineer that the foreman was nearly blind in one eye and that sight was failing in the other. With proper corrective lenses this foreman was not only willing but glad to wear goggles. He enjoyed a greater feeling of security, and undoubtedly was saved from total blindness. This, with modifications, has occurred hundreds of times in scores of plants.

In another plant where a number of valuable, but stubborn, workmen had persistently refused to wear goggles, the safety engineer hung up on the bulletin board a small bottle of alcohol containing a human eye with this simple legend: "This eye belongs to John ——— of the chipping department, but it does him no good now. He lost it because he did not believe in wearing goggles." This same safety engineer constantly carries about with him in a small box in his pocket half of a preserved human eye in which there is still imbedded the steel fragment which necessitated its removal. The eye has been cut so as to afford a cross-section view encased in a transparent preservative. This safety engineer found that men who ordinarily declined to listen to any discussion of the necessity for wearing goggles could, with the preserved human eye as bait, easily be drawn into a serious private conversation about the delicate structure of the eye, the irreparable nature of many eye injuries, and the exact manner in which this particular eye was lost. In nearly every case this conversation would lead to a request from the hitherto stubborn workman for a pair of goggles, though sometimes the request would come after he had had opportunity to think the matter over for several days and to get a vivid mental picture of one of his own eyes being carried about in a safety engineer's pocket or hanging on a safety bulletin board.

Still another safety man once resorted to a device he found so successful that he used it over and over again in different departments and plants: Carrying about with him a tray containing an assortment of artificial eyes, he would take a position a few feet from a workman who either refused to wear goggles or did not wear them consistently. He would pick up one of the glass eyes, look at it carefully and then look at the workman's eyes. Returning the glass eye to the tray, he would pick up another, hold it near a light, and again look closely at the workman's eyes, repeating this as often as necessary. Eventually, the workman would walk over to the safety engineer with some such exclamation as: "Say, what are you trying to do anyway." The safety engineer would then explain that he had just received word that the price of glass eyes was to be greatly increased and so he was planning to put in an order for all the glass eyes they would need during the next year, that, as it was only a matter of time before this particular workman would need a glass eye, he was trying to match it in size and color so that he could include in the order "an eye to fit you." This device was as successful with the workman who saw through the joke as with the fellow who took the safety engineer's explanation seriously. Both realized for the first time what it would mean to have an artificial eye and how dangerously near that state they were.

These measures are admittedly gruesome and radical, but they are justified because they are, in many cases, the only means of inducing certain types of workmen to protect their eyes.

Frank Morris, a well-known safety engineer, is the author of the following terse statement of how to overcome the most common objections to the wearing of goggles: "The workman says goggles make his nose sore; we get him a pair with an adjustable bridge. They hurt his ears; we give him goggles that are kept in position by an elastic band. They hurt his eyes; we send him to an oculist and give him goggles with especially ground or corrective lenses. The goggles are cold; we provide the kind with leather or rubber cushions between the metal frames and the face. They are hot; the leather or rubber insulated goggles obviate this complaint also. They get steamy; rub them with vaseline or glycerin pencil. They carry disease germs; have each pair sterilized."

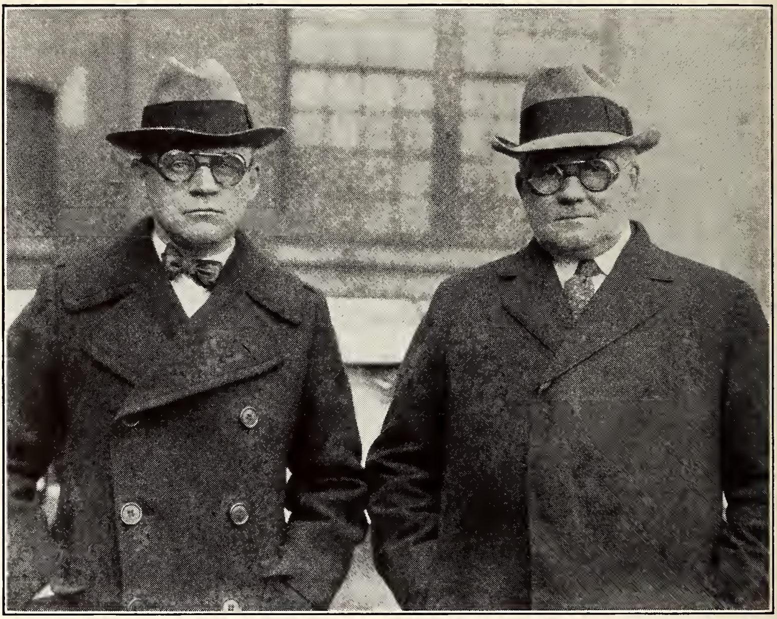

Figure 59.—Safety must come from the top down. Workmen and foremen cannot be expected to wear goggles conscientiously if higher executives risk their eyes by coming into dangerous departments without goggles. That is why Harry Guilbert, safety engineer of the Pullman Company, and William MacLaren, general superintendent (shown above), are never seen without goggles in their plants.

One safety engineer keeps posted on every safety bulletin board in the plant a standing offer of a five dollar reward for any person who sees him about the plant not wearing goggles. There is need for a great deal more of this sort of spirit. Workmen cannot be expected to take seriously orders or advice from men who do not practice what they preach. For that reason the efficient safety engineer not only is extremely careful to wear goggles himself whenever he goes into a department where the men are instructed or advised to wear goggles, but he sees to it that visitors, inspectors and even the plant manager wear goggles on such occasions, both as a means of protection and to set a good example for workmen.

Must Keep Everlastingly at It

The safety education of the employe is never an accomplished fact in the sense that the job is done. Here, as in most forms of safety work, it is necessary to keep everlastingly at it. In plants where workmen are convinced that the management is sincere in its efforts to prevent accidents it is not difficult to induce the average employe to wear goggles. But unless there is a continuous campaign of education, a continuous program of inspirational and morale upbuilding activities, a continuous enforcement of the principle that safety is as important as production, there is the danger of workmen momentarily tiring of their goggles, of their forgetting goggles at home and being willing to work for a day without protection, or of their giving way temporarily to one of the many temptations to discard protective devices. It is just such momentary lapses that cause the blinding of hundreds of men and women yearly.

CHAPTER X

THE SAFETY MOVEMENT AND ITS EFFECT ON THE EYE HAZARDS OF INDUSTRIAL OCCUPATIONS

The greatest influence for the elimination of the eye hazards of industrial occupations is, of course, the general industrial safety movement. There are, undoubtedly, numerous plants where, because of several very costly eye accidents, greater attention is being given to the prevention of this particular type of accident than to the prevention of accidents in general. On the whole, however, the best results in the prevention of accidental injury to the eyes and in the conservation of vision through proper lighting and sanitation are to be found in those plants which are doing good all-round safety work.

It is, therefore, appropriate to consider briefly the history of the safety movement in America, the existing machinery for stimulating industrial accident prevention, and the future possibilities in this direction. As mentioned in an earlier chapter, it is our belief that workmen's compensation legislation has been the greatest single force for industrial safety in America. It is our opinion that this will continue to be the case so long as the right to engage workers for hazardous operations is not restricted to men and women with sufficient vision and regard for human life and limb to provide voluntarily every possible safeguard against accidental injury or needless impairment of health—and there is, of course, no indication that there will ever be such restrictions.

The National Safety Council

Aside from legislation, the National Safety Council has been able through its vast membership to accomplish more than any other agency, for the elimination of industrial accidents of all sorts. The Council was organized September 25, 1913. In a decade the membership of this co-operative, non-commercial safety organization grew from a nucleus of fourteen to more than 3,000 industrial concerns employing millions of men and women and operating approximately 5,000 factories, mines, railways, and other public utilities. At the same time the number of men (there are also a few women) professionally engaged in the direction of industrial accident prevention activities in the United States mounted from a handful to several thousands.

Periodically Delivered Service to Industries

The officers of the National Safety Council soon realized that what was needed was not only a clearing house of safety information where the interested employer might go for help, but a definite, periodically delivered service to industry—a service that would educate employer and employe as to their respective responsibilities and opportunities for averting accidents, that would continuously inspire and encourage both to greater efforts, and keep both informed of the latest discovered means of preventing accidents. This realization led to the development of the now extensive bulletin service of the National Safety Council through which tens of thousands of illustrated posters, showing the right and wrong way of doing things, are sent to members of the Council each month for posting where workmen congregate or pass regularly. A later development in the same direction was the NATIONAL SAFETY NEWS the monthly magazine published by the Council, through which professional safety men and industrial executives responsible for, or especially interested in, accident prevention are informed of the latest developments in that field.

The Council also issues at frequent intervals Safe Practices Pamphlets, each taking up in detail a particular class of hazards, some equipment or type of industrial machinery and describing what constitutes safe practice in the construction and use of such equipment or machinery. These treatises are prepared by the Engineering Department of the Council with the assistance of a conference committee of about fifty of the country's best safety engineers.

The need soon became apparent for local organizations to conduct meetings for workmen, foremen and executives, and to accomplish other aims. The National Council, therefore, set about organizing such locals, of which there are now some forty in operation.

From the inception of the Council the headquarters office began to develop a safety library. What began as a file of information voluntarily contributed by members has developed into a library on accident prevention and industrial health which now has more than 10,000 booklets and pamphlets, 500 books, 5,000 clippings of special articles, and 1,500 blue prints and photographs, all having to do with the prevention of industrial accidents and the promotion of the health of industrial workers.

The educational, inspirational, and informative activities of the National Safety Council culminate each year in a Safety Congress where several thousand men and women meet to hear a hundred or more prepared addresses, to discuss informally their respective problems and accomplishments, to exchange ideas, and to renew acquaintances. In recent years the Council has begun to hold smaller meetings at more frequent intervals and in different sections of the country, largely for the benefit of the safety men who cannot attend the annual conferences.

The Council is essentially a service-to-members organization financed entirely by membership dues. Any industrial or commercial organization or public utility may become a member of the Council on payment of dues according to a sliding scale based on the number of employes. Libraries, educational institutions, and individuals are admitted as associate members. The headquarters of the Council are now in Chicago.

The American Museum of Safety

In a more restricted way, the American Museum of Safety, formerly known as the Safety Institute of America, is carrying on equally constructive work. Financed largely through contributions by public-spirited men and women, and to some extent by the membership dues of industrial concerns, the Museum is primarily a public service organization. Its principal function is to stimulate accident prevention and health promotion work through the offering of medals and other prizes and to assist industries, mines, and utilities by exhibiting devices, appliances, and materials used for the protection of the life and health of industrial workers.

The American Museum of Safety is, like the Council, a co-operative and non-commercial association. The Museum is at 120 East 28th Street, New York City, and the headquarters of the organization maintaining it are at 141 East 29th Street, New York City.

The employer or safety director who visits the American Museum of Safety can see not only exhibits of safety devices and appliances of which there are more than 150—many of them in operation—but also hundreds of photographs, lantern slides, and blue prints of safety equipment which it is impracticable to exhibit at the Museum and graphic descriptions of the plans and methods which are proving most effective for the prevention of accidents in hundreds of industrial properties. The Museum also maintains at its headquarters a library of safety information which is accessible to members and to the general public.

American Society of Safety Engineers

Another national safety organization, the American Society of Safety Engineers, in January of 1924 became affiliated with the National Safety Council and now constitutes the Engineering Section of the Council. The A. S. S. E. differs from both the Council and the Museum of Safety in that its membership is confined to individuals professionally engaged in safety work. The principal activity of this organization has been the holding of monthly meetings for the reading and discussion of professional and technical papers. In common with the Council, the Museum and other safety organizations, the American Society of Safety Engineers has participated in the drafting, development and revision of many important national safety codes under the auspices of the American Engineering Standards Committee.

Other Safety Organizations

Such organizations as the Underwriters' Laboratories, the several regional societies of safety engineers and the most active local councils, together with the more progressive state industrial commissions, the engineering departments of casualty insurance companies, and such branches of the federal government as the Bureau of Standards, the Bureau of Mines, and the Interstate Commerce Commission, are making important and lasting contributions to the general industrial safety movement. The research work of the Bureau of Standards and the safety device testing service of the Underwriters' Laboratories especially are deserving of detailed description such as it is impossible, because of space limitations, to attempt here.

While there can be no such thing as competition in safety work—that is, competition as it is understood in commercial affairs—there is always the possibility of unnecessary duplication. The fact that, notwithstanding the many safety organizations in existence, there has been no noticeable duplication of effort is one of the highest compliments that can be paid to the executives and directors of these organizations.

The National Committee for the Prevention of Blindness

The position of the National Committee for the Prevention of Blindness with respect to the national safety movement was stated in the preface of this volume. It is appropriate here to mention briefly the nature and functions of the Committee not only in the industrial field, but in the general life of our country. The objects of this Committee are: (1) to endeavor to ascertain, through study and investigation, any causes, whether direct or indirect, which may result in blindness or impaired vision; (2) to advocate measures which shall lead to the elimination of such causes; (3) to disseminate knowledge concerning all matters pertaining to the care and use of the eyes. The Committee serves as a bureau of information and an agency of helpfulness to all who are interested in the movement to prevent blindness and conserve vision.

That part of its program which has been devoted to the prevention of eye accidents in the industries has been carried forward in large part by co-operative effort with national, state, and local labor departments and commissions, the National Safety Council, the American Museum of Safety, and other organizations mentioned in the foregoing.

The Committee has distributed some fifty thousand sets of large posters, which have been displayed in factories and other industrial properties from coast to coast. The Committee has also distributed among the industries thousands of copies of its publications concerning prevention of the spread of trachoma and concerning the general care and protection of the eyes. The educational work of the Committee has also been carried forward through numerous talks by its officers and staff, newspaper and magazine publicity, correspondence with individual safety engineers, and industrial executives and by direct contacts with industrial concerns.

The efforts to assist in the general movement for industrial safety through the elimination or alleviation of the eye hazards of industrial occupations represent only one of the several important phases of the work of the National Committee for the Prevention of Blindness. Through the activities of the Committee and its numerous co-operating bodies the frequency of babies' sore eyes—which a decade ago was the greatest single cause of blindness—has been reduced by 50 per cent. for the country at large and made negligible in many communities. In recent years the Committee has given a great deal of attention to conserving the eyes of children of school age and toward this end has induced normal schools and teachers' colleges to include in their curricula such material as will equip the teacher of tomorrow to recognize common eye diseases and defects and to conduct her classes in such a way as to conserve the sight not only of children with defective vision but of children with normal vision. The Committee is participating in the development of a new code of school lighting under the auspices of the American Engineering Standards Committee, and is constantly answering inquiries of persons seeking information concerning proper lighting in schools, homes, and factories. During the latter half of 1923 the Committee initiated a nation-wide study of the extent and causes of accidental injury to eyes in homes, on the streets and in other public places. This study will continue at least over a period of one year and will be followed by a report containing recommendations for the elimination of the conditions constituting the principal causes of such injuries.

The Committee is exclusively a public service organization, supported entirely by membership dues and contributions from public-spirited and philanthropic men and women. It welcomes as members all persons interested in promoting public welfare and contributing to the sum of human happiness and efficiency.

APPENDIX I

INDUSTRIAL POISONS PRESENTING HAZARDS TO THE EYES

Acetaldehyde

Symptoms to look for: Irritation of the mucous membranes of the nose, larynx, bronchi, *and eyes;* acceleration of the heart's action; profuse night sweats.

Those exposed to this hazard are: Aldehyde pump men; celluloid makers; dye makers; explosives workers; mirror silverers; varnish makers; vinegar workers.

Acrolein

Symptoms to look for: Itching in the throat; *irritation of the eyes, exciting lachrymation; conjunctivitis;* irritation of the air passages; bronchial catarrh.

Those exposed to this hazard are: Bone renderers; fat renderers; galvanizers; lard makers; linoleum makers; linseed oil boilers; soap makers; stearic-acid makers; tallow refiners; tinners; varnish boilers.

Ammonia

Symptoms to look for: Acute inflammation of the respiratory organs, cough, edema of the lungs, chronic bronchial catarrh, *redness of the eyes,* increased secretion of saliva, retention of the urine.

Those exposed to this hazard are: Acetylene makers; ammonium-salts makers, artificial-ice makers, artificial-silk makers; boneblack makers; bronzers; coke-oven workers; dye makers; dyers; galvanizers; gas (illuminating) workers; gas purifiers; glue workers; mercerizers; refrigerating-plant workers; salt extractors (coke-oven by-products); sewer workers; shellac makers; shoe finishers; soda makers; sugar refiners; tinners; varnish makers.

Carbon Disulphide

Symptoms to look for: Headache, pain in the extremities, trembling, deafness, reduction of the reflexes, acceleration of the heart's action, nausea, digestive trouble, emaciation, *disturbance of sense of vision,* excitement and violent temper followed by depression, hyperstimulation of sexual instinct, later its abnormal decline, chronic dementia.

Those exposed to this hazard are: Ammonium-salts makers; artificial-silk makers; asphalt testers; carbon-disulphide makers; celluloid makers; cementers (rubber shoes); cement mixers (rubber); dry cleaners; driers (rubber); enamelers; glue workers; insecticide workers; match-factory workers; oil extractors; paint makers; paraffin workers; putty makers; reclaimers (rubber); smokeless-powder makers; sulphur extractors; tallow refiners; vulcanizers.

Chloride of Lime

Symptoms to look for: Irritating cough, inflammation of upper air passages, difficulty of breathing, bronchitis, asthma, sometimes hemoptysis, *conjunctivitis, lachrymation,* hyperhidrosis, burning eruption on the skin.

Those exposed to this hazard are: Bleachers; chloride of lime makers; chloroform makers; disinfectant makers; dye makers; laundry workers; tannery workers.

Chlorodinitrobenzol

See *Nitrobenzol.*

Chloronitrobenzol

See *Nitrobenzol.*

Chromium Compounds

Symptoms to look for: Pitlike, phagedenic ulcers, very difficult to heal and very painful; perforation of the nasal septum at the cartilaginous portion, *irritation of the conjunctiva,* small areas of inflammation in the lungs, inflammation of the kidneys, chronic gastritis, anemia.

Those exposed to this hazard are: Artificial-flower makers; battery (dry) makers; bleachers; calico printers; candle (colored) makers; chromium workers; color makers; compounders (rubber); dye makers; dyers; enamelers; glass mixers; glaze dippers (pottery); glaze mixers (pottery); ink makers; linoleum colorers; lithographers; match-factory workers; mixers (rubber); mordanters; paperhangers; pencil (colored) makers; photo-engravers; photographic workers, pressroom workers (rubber); rubber-tire builders; rubber washers; rubber workers; tannery workers; vulcanizers; wall-paper printers; wax-ornament workers; wood stainers.

Dimethyl Sulphate

Symptoms to look for: Strongly corrosive effect on the skin and mucous membranes, hoarseness, *lachrymation, conjunctivitis*, edema, *photophobia*.

Those exposed to this hazard are: Dimethyl-sulphate makers; dye makers; perfume makers.

Dinitrobenzol

See *Nitrobenzol*.

Hydrochloric Acid

Symptoms to look for: Irritation of mucous membranes; *conjunctivitis;* coryza; pharyngeal, laryngeal, and bronchial catarrh; dental caries.

Those exposed to this hazard are: Acid dippers; acid finishers (glass); acid mixers; acid recoverers; acid transporters; alkali-salt makers; ammonium salts makers; aniline makers, battery (dry) makers; calico printers; camphor makers; carbolic-acid makers; carbonizers (shoddy); cartridge dippers; dye makers; dyers; enamel makers; fertilizer makers; galvanizers; glass finishers; glass mixers; glue workers, hydrochloric acid makers; jewelers; petroleum refiners; picklers; pottery workers; reclaimers (rubber); rubber workers; shoddy workers; solderers; sulphur-chloride makers; tinners; vignetters; zinc-chloride makers.

Hydrofluoric Acid

Symptoms to look for: *Intense irritation of the eyelids and conjunctiva,* coryza, bronchial catarrh with spasmodic cough; ulceration of the nostrils, gums, and oral mucous membrane; painful ulcers of the cuticle, erosion and formation of vesicles, suppuration under the finger-nails.

Those exposed to this hazard are: Antimony fluoride extractors; art-glass workers; bleachers; dyers; etchers; fertilizer makers; glass finishers; silicate extractors.

Methyl Alcohol

Symptoms to look for: Headache; nausea; abdominal cramps; ringing in the ears; muscular prostration; insomnia; delirium; difficulty of breathing; inflammation of the throat and mucous membrane of the air passages; *conjunctivitis; serious affections of the retina and optic nerve resulting in blindness;* fatty degeneration of the liver.

Those exposed to this hazard are: Aldehyde pumpmen; art-glass workers; artificial-flower makers; artificial-silk makers; bookbinders; bronzers; brush makers; calico printers; celluloid makers; cementers (rubber shoes); dimethylsulphate makers; dry cleaners; dryers (felt hats); dye makers; explosives workers; feather workers; felt-hat makers; filament makers (incandescent lamps); fitters (shoes); furniture polishers; gilders; hardeners (felt hats); incandescent-lamp makers; ink makers; japan makers; lacquer makers; lasters (shoes); linoleum makers; millinery workers; mottlers (leather); painters; paint makers; patent-leather makers; perfume makers; photo-engravers; photographers; polishers; shellac makers; shoe-factory operatives; shoe finishers; soap makers; stiffeners (felt hats); stitchers (shoes); type cleaners; upholsterers; varnish makers; vulcanizers; wood-alcohol distillers; woodworkers.

Nitrobenzol and other Nitro Compounds of Benzol and its Homologues

Symptoms to look for: Icteric skin which gradually becomes cyanotic, methemoglobin formation, general debility, anemia, presence of hematoporphyrin, albumin, and sometimes free poison in the urine; skin eruptions, *visual disturbances*, dyspnea, odor of bitter almonds in breath.

Those exposed to this hazard are: Aniline makers; dye makers; explosives workers; perfume makers; smokeless-powder makers; soap makers.

Nitroglycerin

Symptoms to look for: Severe headache, vertigo, nausea, *paralysis of the muscles of the head and eyes* as well as of the lower extremities, cyanosis, reddening of the countenance, burning in the throat and stomach, disturbances of digestion, trembling, neuralgia, colic, retarded respiration and heart action, obstinate ulcers under nails and on the finger tips, eruptions on the plantar aspect of the feet and interdigital spaces, with extreme dryness and formation of fissures.

Those exposed to this hazard are: Explosives workers; nitroglycerin workers; shell fillers.

Nitronapthalene

See *Nitrobenzol.*

Nitrous Gases and Nitric Acid

Symptoms to look for: Irritation of air passages, cough, labored respiration, *inflammation of the eyes*, corrosion of the teeth, erosion and perforation of nasal septum.

Those exposed to this hazard are: Acid dippers; acid mixers; acid recoverers; acid transporters; aniline makers; artificial-leather makers; bleachers; carroters (felt hats); cartridge dippers; celluloid makers; dimethyl-sulphate makers; dippers (guncotton); enamelers; etchers; explosives workers; felt-hat makers; fertilizer makers; fur preparers; galvanizers; glue workers; guncotton dippers; guncotton wringers; imitation pearl makers; incandescent-lamp makers; jewelers; lithographers; miners; mordanters; nitrators; nitric-acid workers; nitroglycerine workers; photo-engravers; picklers; picric-acid makers; refiners (metals); soda makers; steel engravers; sulphuric-acid workers; towermen (sulphuric acid); wringers (guncotton).

Picric Acid

Symptoms to look for: Itching, inflammation of the skin, vesicular eruptions, yellow pigmentation of epidermis and *conjunctiva,* inflammation of buccal mucous membrane, digestive disturbances, vertigo, jaundice, nasal catarrh, nephritis.

Those exposed to this hazard are: Dye makers; dyers; explosives workers; photographers; picric acid makers; shell fillers; smokeless-powder makers.

Sulphur Dioxide

Symptoms to look for: *Irritation of the mucous membrane of respiratory organs and eyes,* spasmodic cough, bronchial catarrh, digestive disturbances, blood-tinged mucus.

Those exposed to this hazard are: Alkali-salt makers; blast-furnace workers; bleachers; brass founders; brick makers; broom makers; carbolic acid makers; chambermen (sulphuric acid); chargers (zinc smelting); copper smelters; dye makers; fertilizer makers; flue cleaners; fruit preservers; fumigators; galvanizers; glue workers; lead smelters; mercury smelters; oil-flotation-plant workers; petroleum refiners; pottery workers; pyrites burners; refiners (metals); rubber workers; storage battery makers; sugar refiners; sulphite cooks; sulphur burners; sulphurers (hops and malt); sulphuric-acid workers; tannery workers; towermen (sulphuric acid); zinc smelters.

Sulphuretted Hydrogen

Symptoms to look for: Headache, debility, vertigo, nausea, disturbances of digestion, sallow complexion and emaciation, slowing of the pulse, *conjunctival catarrh*, tendency to the formation of boils.

Those exposed to this hazard are: Alkali-salt makers; artificial-silk makers; blast-furnace workers; bronzers; cable splicers; celluloid makers; dye makers; fertilizer makers; flax-rettery workers; gas (illuminating) workers; gas purifiers; glue workers; match-factory workers; miners; oil-flotation-plant workers; petroleum refiners; pyrites burners; sewer workers; soda makers; sodium sulphide makers; starch makers; sugar refiners; tannery workers.

Tar

Symptoms to look for: Tar itch, diffuse acne, eczema or psoriasis, loss of appetite, nausea, diarrhea, headache, numbness, vertigo, albuminuria, edema, ischuria, *conjunctivitis*, bronchitis.

Those exposed to this hazard are: Battery (dry) makers; briquet makers; brush makers; chimney sweepers; coke-oven workers; cord makers; flue cleaners; gas (illuminating) workers; insulators; paint makers; paraffin workers; pavers; petroleum refiners; roofers; roofing-paper workers; still (coal-tar) cleaners; tar workers; wood preservers.

Turpentine

Symptoms to look for: *Irritation of the mucous membrane of the eyes*, nose, and upper air passages; cough, bronchial inflammation; salivation; giddiness, headache, irritation of the kidneys, odor of violets in urine, severe irritation of the skin, eczema and hardening of the epidermis.

Those exposed to this hazard are: Art-glass workers; cable splicers; calico printers; camphor makers; cementers (rubber shoes); decorators (pottery); dry cleaners; dye makers; enamelers; enamel makers; feather workers; furniture polishers; japan makers; lacquer makers; linoleum makers; lithographers; millinery workers; painters; paint makers; patent-leather makers; printers; rubber workers; sealing-wax makers; shellac makers; transfer workers (pottery); turpentine extractors; varnish makers.

APPENDIX II

GOGGLE CODE OF THE AMERICAN STEEL AND WIRE COMPANY

Department	Occupations in which the use of goggles is compulsory	Occupations in which the use of goggles is desirable
All Departments.	Chipping iron, steel and other metals. Grinding on emery wheels not fully protected with hood and eye shields. Pouring babbitt and other molten metals.	
Blast Furnaces.	Keepers. Helpers and cinder men. Ladle house men. Cutting rivets. Relining furnaces, stoves, etc.	Stove tenders.
Pig Casting.	Pig machine operators.	
Bessemer.	Iron tappers at cupolas. Mixer operators. Manganese men. Steel pourers and helpers. Removing caps from moulds.	Cinder men.
Open Hearth.	Steel tappers. Steel pourers and helpers. Removing caps from moulds. Charging machine operators.	Cinder men.
Foundries.	Tappers at cupolas. Moulders when handling molten metal. Sand blasting. Chipping castings.	
Blooming Mills.	Roughers at rolls.	Soaking pit crane-men.
Red Mills.	Chipping cinder from heating furnaces.	Roughers.

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Department	Occupations in which the use of goggles is compulsory	Occupations in which the use of goggles is desirable
Gas Producers.	Breaking coal.	Firemen when opening poke holes. Handling ashes.
Wire Mill and Cleaning House.	Handling and pouring acid. Slaking lime. Soap making when filling kettles. Pricking plates.	Picking up scrap.
Galvanizing, Tinning, Varnishing, Nail Galvanizing and Tempering.	Placing lead, spelter and tin in pans. Stirring metal in pans. Dressing spelter pans. Gigging spelter pans. Skimming metal in pans. Baling out pans. Placing or removing headings from pans. Feathering tin and zinc. Making flux for acid tanks. Handling and pouring acid. Refining lead, zinc and tin. Dip galvanizing rails. Oxy-acetylene welding and cutting.	Picking up scrap.
Nail and Staple.	Adjusting nail machines. Adjusting staple machines.	Picking up scrap.
Field and Barbed Fence.		Picking up scrap.
Rope and Cable.	Splicing rope and cable when pouring hot metal into sockets.	Picking up scrap.
Spring Mill.	Tempering—See above.	Picking up scrap.
Shafting, Straightening and Cutting.		Picking up scrap.

Department	Occupations in which the use of goggles is compulsory	Occupations in which the use of goggles is desirable
Machine Shop.	Chipping iron, steel and other metals. Grinding on emery wheels not fully protected with hood and eye shield. Dressing emery wheels and grindstones. Pouring babbitt or other molten metals. Machining tool steel, cast iron and brass when not using a chip guard.	Grinding on grindstones.
Carpenter Shop.		Turning on wood lathe. Grinding on grindstones.
Roll Shop.	Grinding and chipping rolls. Grinding on emery wheels not fully protected with head and eye shield.	Grinding on grindstones.
Blacksmith Shop.	Chipping and grinding.	Grinding on grindstones.
Structural Shop.	Chipping and grinding. Oxy-acetylene welding and cutting.	Grinding on grindstones.
Electrical.	Switchwork and putting in fuses, soldering joints. Blowing out generators and motors.	Cleaning arc lamps.
Boiler House.	Replacing cage glasses. Chipping brick walls. Chipping scale from drums. Breaking coal.	Unloading coal from cars and boilers. Dumping ashes. Cleaning under boilers.
Yard and Miscellaneous.	Masonry work, chipping concrete, brick, stone, etc. Oxy-acetylene welding and cutting.	Painting stacks. Work in dusty and dirty places.

SUPPLEMENTARY READING LIST
ON
EYE HAZARDS IN INDUSTRIAL OCCUPATIONS

APPENDIX III

SUPPLEMENTARY READING LIST ON THE EYE HAZARDS OF INDUSTRIAL OCCUPATIONS

GENERAL

Blind (The): their condition and the work being done for them in the United States, by Harry Best. Macmillan Co., 66 Fifth Ave., New York City. 1919. 763 p.

"Blindness and accidents," pp. 173–209.

Conservation of the Vision of the Industrial Workers (with discussion), by William W. Blair. American Association of Industrial Physicians and Surgeons. Dr. W. A. Sawyer, Secretary, 343 State St., Rochester, New York. Proceedings, 1919. pp. 96–116.

Eye Conservation, by Earl B. Fowler. In Report of the Federated American Engineering Societies on Waste in Industry. Washington, D. C. McGraw-Hill Book Co., 10th Ave. and 36th St., New York City, Selling Agents. 1921. pp. 374–390. $4.00.

Eye Injuries and Their Prevention, by John R. Brownell. California Safety News. Industrial Accident Commission. San Francisco. May 1917. Vol. 1, pp. 3–8.

Industrial Accident Prevention, by David Stewart Beyer. Houghton Mifflin Co., 16 E. 40th St., New York City. 1916. 421 p. $10.00.

"Eye Protection," chapter 48. pp. 371–377.

Industrial Housekeeping. Safe Practices No. 45. National Safety Council, 168 N. Michigan Ave., Chicago. 1921. 8 p. 25 cents.

Industrial Safety Organization. Safe Practices No. 42. National Safety Council, 168 N. Michigan Ave., Chicago. 1921. 16 p.

Metal Causes of Accidents, by Boyd Fisher. Houghton Mifflin Co., 16 E. 40th St., New York City. 1922. 315 p.

Occupational Injuries and Diseases of the Eye, by Harry Vanderbilt Würdemann. In Industrial Health, edited by George M.

Kober and Emery R. Hayhurst. P. Blakiston's Son & Co., 1012 Walnut St., Philadelphia. 1924. pp. 855–882.

Deals with:

1. Injuries from accidents.
2. Diseases due to occupations involving excessive eye strain.
3. Diseases due to excessive exposure to light and heat.
4. Toxicology or systematic poisoning causing loss of sight.
5. Estimation of economic damage.

Preventing Eye Injuries in Industry. National Safety News, 168 N. Michigan Ave., Chicago. February 1923. pp. 17–20.

Preventing Eye Wastage in Industry, by L. M. Francis. National Safety News, 168 N. Michigan Ave., Chicago. 1923. pp. 27–28.

Safe Heads and Good Eyes, by Walter G. King. In Safety Fundamentals. Safety Institute of America, 141 E. 29th St., New York City. 1920. pp. 61–78. $2.00.

NATURE AND CAUSES

Accidents in Electrical Industries. Safety Engineering, 119 Nassau St., New York City. June 1916. Vol. 31, p. 349.

An analysis of accident reports from 65 public utility companies located in 22 states.

Annual Reports Containing Statistics of Industrial Eye Injuries. Free.

Georgia Industrial Commission, Atlanta, Ga.
Maryland State Industrial Accident Commission, Baltimore, Maryland.
Massachusetts Department of Industrial Accidents, Boston, Mass.
Pennsylvania. Department of Labor and Industry, Workmen's Compensation Board, Harrisburg, Pa.
Wisconsin Industrial Commission, Madison, Wis.
Illinois Industrial Commission, Springfield, Ill.

Biennial Reports Containing Statistics of Industrial Eye Injuries. Free.

Idaho Industrial Accident Board, Boise, Idaho.
Virginia Industrial Commission, Richmond, Va.
Utah Industrial Commission, Salt Lake City, Utah.

Causes and Cost of Industrial Eye Injuries in the United States, compiled by the National Bureau of Casualty and Surety Underwriters. Monthly Labor Review, March 1923. pp. 614–616.

Eye Injuries, by George A. Kingston. In Proceedings of the Fourth Annual Meeting of the International Association of Industrial Accident Boards and Commissions held at Boston. Aug. 21–25, 1917. pp. 269–273. Discussion, pp. 273–281.

Eye Injuries and the Workmen's Compensation Law, by J. E. Brown. Ohio Medical Journal, 131 E. State St., Columbus. 1920. Vol. 16, pp. 909–914.

Industrial Eye Injuries, by F. Allport. New York Medical Journal, 53 Park Place, New York City. 1923. Vol. 117, pp. 733, 736.

Injuries of the Eye, by N. T. Clark. International Journal of Surgery. Burlington, Vermont. 1922. Vol. 35, pp. 31–33.

Injuries to the Eye in Industrial Plants, by T. F. Huey. International Journal of Surgery. 18 E. 41st St., New York City. 1920. p. 378.

Injuries to the Eye, with Report of 1,051 Cases, by Don M. Campbell and John M. Carter. American Journal of Ophthalmology, 7 W. Madison St., Chicago. May 1921. Vol. 4, Series 3, No. 5, pp. 336–344.

Penetrating Eye Injuries, by C. J. Adams. Journal of the Indiana Medical Association, 406 W. Berry St., Fort Wayne, 1921. Vol. 14, pp. 299–305.

Statistics of Industrial Accidents in the United States, by Lucian W. Chaney. U. S. Bureau of Labor Statistics. Bulletin No. 339. Washington, D. C. Government Printing Office, 1923. 60 p. 10 cents.

Number of accidents in specified states, 1920, by location of injury (including eyes), table 30, p. 27.

Study of 1,000 Eye Injuries, by E. L. Vernon. Surgical Journal, 542 Monadnock Block, Chicago. 1922–23. Vol. 29, pp. 139–142.

PREVENTION THROUGH EDUCATIONAL MEANS

Accidents Are Reduced in Direct Proportion as Safety Education Increases, by J. P. Miller. Safety Engineering, 119 Nassau St., New York City. 1922. Vol. 44, pp. 123–124.

Accident Statistics and Accident Prevention, by Royal Meeker. Safety Engineering, 119 Nassau St., New York City. February 1924. Vol. 47, pp. 55–58.

Education in Safety Engineering as Given at the Lynn General Electric Engineering and Apprentice School, by N. M. Du Chemin. Safety Engineering, 119 Nassau St., New York City. August 1921. Vol. 42, pp. 106–112.

Factory Eye Room Saves Workers' Sight and Increases Output, by Sanford De Hart. Industrial Management, 120 W. 32d St., New York City. January 1, 1921. Vol. 61, pp. 23–24.

What has been accomplished by the R. K. Le Blond Machine Tool Co. through the installation of an eye room.

Fixing the Responsibility for an Accident. Safety Engineering, 119 Nassau St., New York City. October 1920. Vol. 40, pp. 155–159.

A sketch presented at the Ninth Annual Safety Congress. National Safety Council.

The Principles and Practice of Safety; a handbook for technical schools and universities, by The National Safety Council, 168 N. Michigan Ave., Chicago. 1919. 72 p.

Safety Bulletins and Bulletin Boards—Safe Practices No. 38. National Safety Council, 168 N. Michigan Ave., Chicago. 15 p. 25 cents.

Safety Organization and Education, by E. I. Du Pont de Nemours & Co., Wilmington, Delaware. 1918. 68 p. Free.

Suggestion Systems—Safe Practices No. 40. National Safety Council, 168 N. Michigan Ave., Chicago. 15 p. 25 cents.

Training Courses in Safety and Hygiene in the Building Trades. U. S. Federal Board for Vocational Education. Washington Government Printing Office, 1919. 127 p. Trade and Industrial Series No. 6, Bulletin No. 31. Free.

Wearing Goggles, by Buell W. Nutt. Safety Engineering, 119 Nassau St., New York City. January 1919. Vol. 37, pp. 13–15.

Suggestions for getting men to wear goggles.

PREVENTION THROUGH MECHANICAL MEANS

Acids and Caustics—Safe Practices No. 25. National Safety Council, 168 N. Michigan Ave., Chicago. 15 p. 25 cents.

Cleaning and Finishing Rooms in Foundries—Safe Practices No. Me 1. National Safety Council, 168 N. Michigan Ave., Chicago. 12 p. 10 cents.

Drinking Water, Wash and Locker Rooms, and Toilet Facilities—Safe Practices No. 27. National Safety Council, 168 N. Michigan Ave., Chicago. 16 p. 25 cents.

Eye Protection in the Machine Industry. Machinery, 10th Ave. and 36th St., New York City. May 1918. Vol. 24, pp. 818–820.

Causes of injuries to the eye and methods of prevention.

Gas and Electric Welding—Safe Practices No. 23. National Safety Council, 168 N. Michigan Ave., Chicago. pp. 12–16. 10 cents.

Goggles (a Detailed Description of Four Types). National Safety Council, 168 N. Michigan Ave., Chicago. Safe Practices. Vol. No. 14, pp. 141–148. 10 cents.

How Goggles Should Be Worn, by Frederick Willson. National Safety News, 168 N. Michigan Ave., Chicago. May 1924. Vol. 9, pp. 31–32.

Machine Shop Machinery—Safe Practices No. 39. National Safety Council, 168 N. Michigan Ave., Chicago. 16 p. 25 cents.

Safe Clothing for Men and Women in Industry. Safe Practices No. 16. National Safety Council, 168 N. Michigan Ave., Chicago. 11 p. 10 cents.

Safety Engineering in Automotive Plants. Automotive Industries, 239 W. 39th St., New York City. December 6, 1917. Vol. 37, pp. 1011–1013.

Problems of protecting the eyes of workmen while working on grinders outside the regular grinding room.

DEFECTIVE VISION—ITS DETECTION AND CORRECTION

Better Work and More Work Per Man Through Better Sight, by E. LeRoy Ryer and Willard B. Fisher. Industrial Management, 120 W. 32d St., New York City. February 1922. Vol. 63, pp. 111–117.

Eye examinations and their importance in industrial management.

Care of the Printer's Eyesight. Caxton Magazine and British Stationer, January 1920. Vol. 22, pp. 25–26, 29–30, 33–34. Abstract. Illuminating Engineer, 32 Victoria St., London, S. W. I. February 1920. Vol. 13, p. 28.

Importance of having the eyes properly tested for the printer's trade.

Conserving the Worker's Vision, by Sanford De Hart. American Machinist, 10th Ave. and 36th St., New York City. April 12, 1923. Vol. 58, pp. 537–540.

Tendency of machinists to neglect their eyes. Why examination and correction are essential.

Corrected Eyesight—How It Increased Production, by H. Brown. Factory, Cass and Huron Sts., Chicago. July 1, 1920. Vol. 25, pp. 55–56.

Eye Fatigue in Industry, by M. Poser. Illuminating Engineering Society, 29 W. 39th St., New York City. Transactions, 1921. Vol. 16, No. 8. pp. 431–437.

Eye Strain in Its Relation to Occupations, by George M. Gould. American Journal for Physiological Optics, Southbridge, Mass. January 1920. Vol. 1, No. 1. Extracts. Monthly Labor Review, Washington, D. C., July 1920. Vol. 11, pp. 160–162.

Importance of Eye Strain in Relation to Industry. Monthly Labor Review, Washington, D. C. July 1920. Vol. 11, pp. 160–162.

Investing in Good Eyesight, by P. W. Blair. Factory, Cass and Huron Sts., Chicago. August 1921. Vol. 27, p. 262.

The desirability of an effective plan of eye inspection and correction for conservation of eyesight and improvement of work.

DISEASES AFFECTING THE EYES

GENERAL

Blindness from Industrial Use of Wood Alcohol, by John M. Robinson. Monthly Labor Review. Washington, D. C. March 1918. Vol. 6, pp. 687–689.

Diseases of Occupation and Vocational Hygiene, by G. M. Kober and W. C. Hanson. P. Blakiston's Son & Co., 1012 Walnut St., Philadelphia. 1916. 918 p.

Diseases of Occupation from the Legislative, Social and Medical Points of View, by Thomas Oliver. Methuen & Co., 36 Essex St., W. C., London. 1908.

Glass-blowers' cataracts, p. 379.

Dope Poisoning in the Making of Airplanes, by Alice Hamilton. Monthly Labor Review. Washington, D. C. February 1918. Vol. 6, pp. 289–316.

"The effect of wood alcohol on the eye," pp. 46–49.

The Effect of Lime Sulphur Spray Manufacture on the Eyesight, by James R. Withrow. Journal of Industrial and Engineering Chemistry, 1709 G St., N. W., Washington, D. C. October 1912. Vol. 4, pp. 735–737.

Eye Injuries and Diseases with Special Reference to Eye Strain. Monthly Labor Review. Washington, D. C. August 1917. Vol. 5, pp. 386–391.

Eye Symptomatology in Occupational Diseases, by Donald J. Lyle and Carey P. McCord. Nation's Health, 22 E. Ontario St. Chicago. October 1922. Vol. 4, pp. 613–615. Same. Monthly Labor Review. December 1922. pp. 1344–1350.

Describes occupational nystagmus, affections of the eyes through carbon monoxide poisoning, ocular lead poisoning, methyl alcohol, and occupational cataracts.

Hygiene of the Eye, by J. Green, jr. Modern Medicine, 22 E. Ontario St., Chicago. 1921. pp. 149–154.

Industrial Eye Affections, by J. C. Bridges. Journal of Industrial Hygiene, 240 Longwood Ave., Boston. December 1920.

Industrial Trauma in Relation to the Development of Ocular Tuberculosis, Syphilis, and Neoplasm, by J. W. Charles. Progressive Medicine. Philadelphia. 1923. Vol. 2, pp. 394–396.

Lenticular Opacities in the Eyes of Tinplate Millmen, by J. J. Healy. British Journal of Ophthalmology. London. 1921. Vol. 5, p. 210.

Manual of the Diseases of the Eye for Students and General Practitioners, by Charles H. May. William Wood Co., 51 Fifth Ave., New York City. 440 p.

Report of the American Chemical Society Committee on Occupational Diseases and Hazards in the Chemical Trade. Journal of Industrial & Engineering Chemistry, 1709 G St., N. W., Washington, D. C. May 1923. Vol. 15, pp. 535–537.

Some Industrial Eye Affections, by John C. Bridge. Journal of Industrial Hygiene, 240 Longwood Ave., Boston. December 1920. Vol. 2, pp. 274–278.

Wood Alcohol: A Report on the Chemistry, Technology and Pharmacology of and the Legislation Pertaining to Methyl Alcohol, by Charles Baskerville. In the Second Report of the New York State Factory Investigating Commission. 1913. Vol. 2, pp. 921–1042.

Cataracts

Diseases of Occupation and Vocational Hygiene, by G. M. Kober and W. C. Hanson. P. Blakiston's Son & Co., 1012 Walnut St., Philadelphia. 1916. 918 p.

Glass-Workers' Cataract, by T. M. Legge. In Industrial Health, edited by Geo. M. Kober and Emery R. Hayhurst. P. Blakiston's Son & Co., 1012 Walnut St., Philadelphia. 1924. pp. 883–889.

Glassblowers' Cataract in Chainmakers, by B. H. St. C. Roberts. British Journal of Ophthalmology. London. 1921. Vol 5, p. 216.

Industrial Cataract. Monthly Labor Review. Washington, D. C. September 1921. Vol. 13, p. 657.

Myopia

Cause and Prevention of Myopia, by F. W. Eldridge-Green. Lancet, London. 1921. pp. 469–471.

Cause and Prevention of Myopia, by F. W. Eldridge-Green. Medical Press, London. 1923. Vol. 116, p. 8.

Consequences of Myopia as an Industrial Disease of the Eyes (The), by N. B. Harman. Journal of Ophthalmological Society of the United Kingdom, London, 1922. Vol. xlii, pp. 20–25.

Consequences of Myopia as an Industrial Disease of the Eyes, by N. B. Harman. Journal of Industrial Hygiene, 240 Longwood Ave., Boston. January 1923. Vol. 4, pp. 371–374.

Reading and Writing Desk for Myopes and Those Predisposed to Myopia. Proceedings of the Royal Society of Medicine. London, 1920–21. Vol. 14, Section, Ophthalmology, p. 65.

NYSTAGMUS

British Report on Miners' Nystagmus. Monthly Labor Review, Washington, D. C. July 1922. pp. 140–141.

Campaign Against Miners' Nystagmus in the Colliery District of Liege, Belgium, by N. Stassen. Journal of Industrial Hygiene, 240 Longwood Ave., Boston. April 1921. Vol. 2, pp. 451–455.

Coal Miners' Nystagmus, by Frederick Robson. In South Wales Institute of Engineers Proceedings, 1923. Vol. 39, pp. 527–556. Abstract. International Labor Review, 7 Route De Pregny, Geneva, Switzerland. October 1923. Vol. 8, pp. 591–597.

In Dr. Robson's opinion the chief cause of miners' nystagmus is due to carbon monoxide poisoning.

First Report of the Miners' Nystagmus Committee. Medical Research Council, London. 1922.

Miners' Nystagmus, by F. L. Hoffman. United States Bureau of Mines. Bulletin No. 93. Washington, D.C. Government Printing Office. 1916. 67 p.

Miners' Nystagmus from the Point of View of the Workmen's Compensation Act, by T. Lister Llewellyn. Journal of Industrial Hygiene. 240 Longwood Ave., Boston. December 1922. pp. 335–345.

TRACHOMA

Brief Discussion of Trachoma with Report of Cases, by I. E. Gaston. Northwest Medicine, Seattle. 1921. Vol. 20, pp. 335–338.

Control of Trachoma Among the Alien Labor Companies of the British and American Expeditionary Forces, by G. S. Derby.

New York Medical Journal. 53 Park Place, New York City. 1919. p. 1107.

Diagnosis and Treatment of Trachoma, by W. M. D. Carhart. New York City Department of Health. Reprint Series No. 59. June 1917. 13 p. Free.

Diagnosis of the Trachoma Granules Upon the Limbus of the Cornea, by K. Hiwatari. American Journal of Ophthalmology, 7 W. Madison St., Chicago. 1921. p. 200.

Diagnosis and Treatment of Trachoma, by William Merle D'Aubigne Carhart. New York, 1917. (New York City Health Department Reprint Series No. 59.) 13 p.

Solarization in Trachoma, by J. W. Wright. American Journal of Ophthalmology, 7 W. Madison St., Chicago. 1923. p. 279.

Trachoma; Its Cause, Prevention and Treatment, by W. H. Harrison. Office of Indian Affairs. Washington. Government Printing Office. 1915. 9 p.

Trachoma, Its Nature and Prevention, by John McMullen. Washington. Government Printing Office, 1915. United States Public Health Reports. No. 8. 6 p.

Trachoma; a Public Health Problem of the States, by J. McMullen. Journal of the American Medical Association, 535 N. Dearborn St., Chicago. 1920. Vol. lxxv, pp. 1109–1112.

Trachoma and Our End Results, by J. H. Burleson. Texas State Journal of Medicine, 207½ W. 11th St., Fort Worth, 1922–23. Vol. 18, pp. 20–272.

Treatment of Trachoma (The), by W. L. Benedict. Minnesota Medicine, 210 Commerce Bldg., St. Paul. 1921. pp. 437–440.

INDUSTRIAL LIGHTING

General

Defective Vision and Industrial Accidents, by R. E. Simpson. Safety Engineering, 119 Nassau St., New York City, June 1923. pp. 220–3. Vol. 45.

Effect of Modern Illuminants on the Eye, by G. S. Crampton. Illuminating Engineering Society, 29 W. 39th St., New York City. Transactions. January 1924. Vol. 19, pp. 96–98.

Effects of Quantity and Quality of Illumination Upon the Human Eye and Vision (The), by Charles Sheard. Safety Engineering. Vol. 47, pp. 91–98.

Elimination of Waste in Industry due to Poor Lighting, by Ward Harrison. Chemical and Metallurgical Engineering, 10th Ave. & 36th St., New York City. August 31, 1921. Vol. 25, No. 9. pp. 407–409.

High Cost of Poor Lighting, by R. E. Simpson. Illuminating Engineering Society, 29 W. 39th St., New York City. 1920. Vol. 15, No. 8, pp. 576–581.

How Better Lighting Increased Our Production 25 Per Cent, by J. Magee. Factory, Cass and Huron Sts., Chicago. February 1923. Vol. 30, pp. 148–150.

Illumination and Accident Prevention, by David H. Tuck. Safety Engineering, 119 Nassau St., New York City. August 1920. Vol. 40, pp. 50–52.

Illumination in Work Places, and Tests Therefor, by Emery R. Hayhurst. In Industrial Health, edited by George M. Kober and Emery R. Hayhurst. P. Blakiston's Son and Co., 1012 Walnut St., Philadelphia. 1924. pp. 38–41.

Improving Shop Efficiency by Better Lighting, by Thomas F. Chantler. Safety Engineering, 119 Nassau St., New York City. August 1919. Vol. 38, pp. 53–59.

Industrial Lighting: Ideal Requirements (Legislative and Otherwise) and Practical Solutions, by L. Gaster. Illuminating Engineer, 32 Victoria St., London, S. W. I. March 1922. Vol. 15, pp. 74–82. Discussion, pp. 82–88.

Industrial Lighting as an Accident Hazard, by E. Leavenworth Elliott. In Proceedings of the Ninth Annual Meeting of the International Association of Industrial Accident Boards and Commissions held at Baltimore, Maryland. October 9–13, 1922. U. S. Bureau of Labor Statistics.

Industrial Lighting Equipment and Its Maintenance, by Samuel G. Hibben. Safety Engineering, 119 Nassau St., New York City. January 1921. Vol. 41, pp. 13–18.

Industrial Painting. Safety Engineering. February 1921. Vol. 41, pp. 65–66.

Lighting Conditions in Mines with Special Reference to the Eyesight of Miners. T. L. Lewellyn. Illuminating Engineer, 32 Victoria St., London, S. W. I. March 1920. Vol. 13, pp. 67–79. Discussion, pp. 80–108.

Safety Features of Industrial Lighting, by S. G. Hibben. Illuminating Engineering Society, 29 W. 39th St., New York City. Transactions, 1921. Vol. 16, No. 3, pp. 47–55.

Safety Engineering, 119 Nassau St., New York City. January 1921. Vol. 41, pp. 13–18.

Shop Lighting—Safe Practices No. 22. National Safety Council, 168 N. Michigan Ave., Chicago, Ill. 16 p. 10 cents.

Some Observations on Industrial Lighting, by D. R. Wilson. Journal of Industrial Hygiene, 240 Longwood Ave., Boston, Mass. February 1924. Vol. 5, pp. 371–381.

Survey of Industrial Lighting in Fifteen States, by R. O. Eastman. Illuminating Engineering Society, 29 W. 39th St., New York City. Transactions, 1920. Vol. 15, No. 1. pp. 77–93.

Artificial Lighting

Artificial Light and Our Eyes, by E. A. Sperry. Illuminating Engineering Society, 29 W. 39th St., New York City. Transactions, 1923. Vol. 18, pp. 325–8.

Chart to Facilitate the Design of Lighting Systems. Electrical World, 10th Ave. at 36th St., New York City. April 19, 1919. Vol. 73, pp. 778–779.

Special consideration of each case preferable, but approximate solution is given by a diagram.

Suggestions for Industrial Lighting Lay Outs, prepared by the Metropolitan Life Insurance Co. Policyholders' Service Bureau. 1 Madison Avenue, New York City. 10 p. mimeo. Free.

Lighting Codes

General Summary of Industrial Lighting Regulations that Are Included in Existing Codes together with the Present Tendencies toward Future Legislation, by G. H. Stickney. Industrial Engineer, Old Colony Bldg., Chicago, Ill. September 1923. Vol. 81, pp. 447–451.

Symposium—Application of Industrial Lighting Codes. Illuminating Engineering Society, 29 W. 39th St., New York City. Transactions, 1919. Vol. 14, No. 9. pp. 435–437. Discussion, pp. 480–489.

Codes of Wisconsin, New York, New Jersey, Pennsylvania and Federal code.

NATURAL LIGHTING

Bringing Daylight into Your Present Building, by W. T. Spivey. Factory, Cass and Huron Sts., Chicago. September 1923. Vol. 31, pp. 312–315.

Natural Lighting of Industrial Building, by W. R. Fogg. Architectural Forum, 383 Madison Ave., New York City. September 1923. Vol. 39, pp. 117–121.

Proportioning Skylight and Window Areas; Method of Computing the Amount of Glass Necessary to Provide Adequate Natural Light for Different Classes of Building, by M. William Ehrlich. Sanitary and Heating Engineering, 15 E. 40th St., New York City. February 15 and March 1, 1918. Vol. 89, pp. 229; 299–302.

Survey of Natural Illumination in an Industrial Plant, with Special Reference to the Use of the Indoor-Outdoor Ratio in Establishing Standards of Daylight Illumination, by C. E. A. Winslow and Leonard Greenburg. Public Health Reports. United States Public Health Service, Washington, D. C. April 14, 1922. Vol. 37, pp. 876–887.

LEGISLATION—STANDARDS—CODES

Code of Lighting Factories, Mills and Other Work Places, prepared under sponsorship of the Illuminating Engineering Society. New York. American Standard, approved December 31, 1921, by the American Engineering Standards Committee. United States Bureau of Labor Statistics. Bulletin No. 331. Washington. Government Printing Office, 1923. 29 p.

Compensation for Eye Injuries from a Medical Standpoint, by Francis D. Donoghue. In Proceedings of the Ninth Annual meeting of the International Association of Industrial Accident Boards and Commissions held at Baltimore, Maryland, October 9–13, 1922. U. S. Bureau of Labor Statistics, No. 333. Washington, D. C. Government Printing Office, 1923. pp. 180–185.

Gives table showing provisions of state laws as to compensation for loss of vision.

Compensation for Injuries to the Eye, by William Tarun. In Proceedings of the Ninth Annual Meeting of the International Association of Industrial Accident Boards and Commissions held at Baltimore, Maryland, October 9–13, 1922. U. S. Bureau of Labor Statistics. Bulletin No. 333. Washington, D. C. Government Printing Office, 1923. pp. 170–173. Discussion, pp. 173–179.

Industrial Lighting Code for Factories, Mills, Offices and Other Work Places. Wisconsin Industrial Commission, Madison, 1921. 3d edition revised. 51 p.

Lighting of Factories, Mills and Workshops (The), by C. E. Clewell. In Illuminating Engineering Practice. Lectures delivered at the University of Pennsylvania. Philadelphia, September 26 to 28, 1916, under the joint auspices of the University and the Illuminating Engineering Society. McGraw-Hill Book Co., New York, 1917. pp. 337–361.

Methods of Accident Reporting and Claim Procedure under Workmen's Compensation, by Carl Hookstadt. In Proceedings of the Eighth Annual Meeting of the International Association of Industrial Accident Boards and Commissions, held at Chicago, Ill. September 19–23, 1921. U. S. Bureau of Labor Statistics. Bulletin No. 304. Washington, D. C. Government Printing Office, 1922. pp. 176–201. Discussion, pp. 201–221.

Discusses in detail the methods of accident reporting and claim procedure employed by compensation commissions and funds in 20 states investigated by the Bureau of Labor Statistics.

National Safety Code for the Protection of the Heads and Eyes of Industrial Workers. U. S. Bureau of Standards. 2d edition. December 29, 1922. Washington, D. C. Government Printing Office, 1923. 66 p. 10 cents.

Report on Eye Injuries, by Francis D. Donoghue. In Proceedings of the Seventh Annual Meeting of the International Association of Industrial Accident Boards and Commissions held at San Francisco, Calif. September 20–24, 1920. U. S. Bureau of Labor Statistics. Bulletin No. 281. Washington, D. C. Government Printing Office, 1921. pp. 46–53. Discussion, pp. 53–63.

Specific compensation payments and the simplifying of administrative problems following ocular injury.

Rating Losses of Industrial Vision under the New York State Compensation Law, by William Mehl. Medical Record, 51 Fifth Av., New York City. January 28, 1922. Vol. 101, pp. 145–148.

Paper read before the annual meeting of the New York State Society of Industrial Medicine, Syracuse, N. Y. December 7, 1921.

Safety Legislation in General, Employes are Protected by State Legislation, the Public by Municipal. Best method delegates legislative authority and duty of enforcement to same officials. Safety Engineering, 119 Nassau St., New York City. July 1923. Vol. 46, p. 14–19.

What Constitutes Industrial Blindness, by Edward Stieren. Nation's Health, 22 E. Ontario St., Chicago, Ill. June 1921. Vol. 3, pp. 369–370.

Workmen's Compensation Acts in the United States—Medical Aspect. National Industrial Conference Board, 10 E. 39th St. New York City. 1923. Research report No. 61. 282 pp. $3.00.

RADIANT ENERGY

Effect of Ultra-Violet Rays on the Eye, by C. R. Kindall. Chemical and Metallurgical Engineering, 10th Ave. at 36th St., New York City. December 1, 1920. Vol. 23, p. 1071.

Eye Protection in Welding Operations, by R. R. Butler. Engineering, 35 and 36 Bedford St. Strand, London, W. C. June 18, 1920. Vol. 109, pp. 823–826.

Eye Protection in Welding Operations, by C. Sylvester. Scientific American Monthly, 233 Broadway, New York City. July 1920. pp. 52–53.

Search for a transparent material that will exclude infra-red and ultra-violet rays.

Glasses for Protecting the Eyes from Injurious Radiations, by William W. Coblentz and W. B. Emerson. U. S. Bureau of Standards, Washington, D. C. 1919. Technologic paper No. 93. 25 p. 10 cents.

Protective properties of spectacle glasses, particularly glasses which shield the eye from infra-red or so-called heat rays.

Pathological Effects of Radiation on the Eye, by F. H. Verhoeff and L. Bell. Illuminating Engineering Society, 29 W. 39th St., New York City. Transactions, 1921. Vol. 16, No. 9, pp. 625–664.

Physiological Effects of Radiant Energy, by Charles Sheard. Safety Engineering, 119 Nassau St., New York City. May–June, 1923. Vol. 45, p. 171.

Relative Sensibility of the Average Eye to Light of Different Colors and Some Practical Applications to Radiation Problems, by William W. Coblentz and W. B. Emerson. U. S. Bureau of Standards. Scientific papers No. 303. Washington, D. C. Government Printing Office, 1917. pp. 167–236. 10 cents.

Testing of Goggles for Protection Against Radiant Energy, by Charles E. Oakes. National Safety Council. Proceedings of the Eighth Annual Meeting of the National Safety Council, 168 N. Michigan Av., Chicago, Ill. 1919. pp. 782–789. Discussion, pp. 790–791.

Ultra-Violet and Visible Transmission of Eye-Protective Glasses (The), by K. S. Gibson and H. J. McNicholas. U. S. Bureau of Standards. Washington, D. C. Government Printing Office, 1919. 47 p. 10 cents.

Report upon the spectral transmission of the various glasses commercially promoted as valuable in protecting the eye from harmful radiant energy.

TREATMENT OF EYE INJURIES

Brief Historical Summary of the Treatment of Trachoma with Special Reference to the Arabian School and the Writings of Ali-el-Aissa (Jesu Hali) (A), Proceedings of the Royal Society of Medicine. London, 1920–21. pp. 43–51.

Clinical Ophthalmology for the General Practitioner; with a foreword by Sir James Mackenzie, by A. Maitland Ramsay. Oxford and New York. Oxford University Press, 35 W. 32d St., New York City. 1920. 520 p.

Diseases of the Eye and Their Treatment, by Henry R. Swanzy. H. K. Lewis, London. 1919. 689 p.

Early Treatment of Injuries to the Eyeball (The), by L. A. Copps. Surgical Journal, 542 Monadnock Block, Chicago. 1922–23. Vol. 29, pp. 171–3.

Economic Aspect in Eye Injuries; a Plea for Early Treatment, by T. L. Llewellyn. British Medical Journal, London. 1921. pp. 118–120.

Eye, Ear, Nose and Throat Nursing, by A. Edward Davis and Beaman Douglas. F. A. Davis, Philadelphia. 1905. 318 p.

A guide for the intelligent care and nursing of the various diseases of the eye, ear, nose and throat. Part 1 is devoted to nursing of eye diseases. pp. 1–169.

Eye Injuries, by L. M. Francis. In Proceedings of the Twelfth Annual Meeting of the National Safety Council, 168 N. Michigan Ave., Chicago, Ill. 1923. pp. 193–199.

Fragment of Steel Removed from Eye, after Two Years, with Magnet. Case Report by S. G. Dabney. Kentucky Medical Journal. Bowling Green. 1920. Vol. 33, pp. 434–436.

Industrial Eye Injuries, by Frank Allport. Safety Engineering, 119 Nassau St., New York City. October 1923. Vol. 46, pp. 165–169.

Prevention and cure of ocular injuries in industrial occupations.

Ophthalmic Use of Some of the More Recent Therapeutic Preparations, by H. S. Gradle. Illinois Medical Journal, 25 E. Washington St., Chicago, Ill. 1921. Vol. 39, pp. 440–443.

Penetrating Injuries to the Eye in Industrial Occupations, by Frank Allport. Safety Engineering, 119 Nassau St., New York City. January–February 1924. Vol. 47, pp. 5–7; 74–6.

Methods of removing foreign bodies from the eye.

Problems of the Care of Industrial Injuries of the Eye, by H. L. Begle. Journal of the Michigan Medical Society, Powers Theater Bldg., Grand Rapids. 1921. Vol. 20, pp. 443–449.

GENERAL

Engineering Revision—the Engineer's Part in Safety, by C. P. Tolman. Safety Engineering, 119 Nassau St., New York City. June 1921. pp. 279–280.

Eye Hazards in the Building Trades, by J. Albert Robinson. Safety Engineering. August 1919. Vol. 38, pp. 93–4.

Eye in Industrial Accidents (The), by Nelson Miles Black. University of Wisconsin, Madison, Wis. Bulletin General Series No. 603. 28 p.

Eye Injuries, by Frank C. Trebilcock. In Proceedings of the Sixth Annual Meeting of the International Association of Industrial Accident Boards and Commissions, held at Toronto, Canada. September 23–26, 1919. U. S. Bureau of Labor Statistics. Bulletin No. 273. Washington, D. C. Government Printing Office. 1920. pp. 261–266. Discussion, pp. 266–271. Same. Modern Medicine, January 1920. Vol. 2, pp. 46–48.

A review of several cases of occupational eye injuries which came under the consideration of the author.

Eye Injuries in Relation to Industrial Organizations and Insurance, by W. N. Sharp. Indianapolis Medical Journal, 634 Occidental Bldg., Indianapolis, Ind. 1921. Vol. 24, pp. 117–121.

Eye Injuries from the Compensation Standpoint, by John A. Jackson. In The Physician in Industry: a symposium published by the National Industrial Conference Board, 10 E. 39th St., New York City. June 1922. Special report No. 22. pp. 66–71. $1.00.

Hygiene of the Eye, by William Campbell Posey. T. B. Lippincott Co., Philadelphia. 1918. 344 p.

Industrial Eye Injuries, by Frank Allport. New York Medical Journal, A. R. Elliott Pub. Co., 53 Park Place, New York City. June 20, 1923. pp. 733–736.

(Experience of the Pullman Company.)

Industrial Hygiene and Medicine, by Edward William Hope. Wm. Wood & Co., New York City. 1923.

Need of Protecting the Eyes in Our Industrial Schools, by W. E. Bruner. Journal of the American Ophthalmological Society. Philadelphia. 1922. Vol. 20, pp. 286–291.

Suggestions for a Uniform Method of Estimating Loss of Visual Efficiency Following Industrial Eye Injuries, by N. M. Black. Journal of the American Ophthalmological Society. Philadelphia. 1921. Vol. 19, pp. 363–380.

Symbol of Safety, by Harry Chase Brearley. Doubleday, Page & Co., 120 W. 32d St., New York City. 1923. 290 pp.

A story of the work of the Underwriters' Laboratories.

The Physiology of the Eye and Its Relation to Railway Signaling, by Nelson M. Black. Illuminating Engineering Society. Transactions, 29 W. 39th St., New York City. 1914. Vol. 9, pp. 425–444.

Safety in a Shipyard, by M. K. Haskins. Safety Engineering, 119 Nassau St., New York City. March 1920. Vol. 39, p. 122.

Experience of the American Shipbuilding Co. at Lorain, Ohio.

Three Periods of "Engineering Revision," by Lucian W. Chaney. Safety Engineering. January 1920. Vol. 39, pp. 1–3.

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